BUILDING SUPERINTENDENCE FOR FRAME, BRICK AND STONE STRUCTURES

NICHOLS

B. RAPPS

New York City

BUILDING SUPERINTENDENCE FOR FRAME, BRICK, AND STONE STRUCTURES

A PRACTICAL TREATISE ON METHODS OF SUPERINTENDING
CONSTRUCTION FOR FRAME AND BRICK DWELLINGS,
APARTMENT AND OFFICE BUILDINGS, INCLUDING INTERIOR TRIM AND EQUIPMENT

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ILLUSTRATED

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INTRODUCTION

FRAME, brick, and stone dwellings have been known for centuries, but this does not mean that the problem of properly superintending the construction of such a dwelling is the same now that it was even twenty-five years ago. The general problem of preparing the foundation, for instance, might be considered to have remain unchanged, but we know that the increasing use of concrete has radically changed the specifications. Furthermore, changes in city ordinances, up-to-date requirements, labor-saving appliances, etc., may also easily have had considerable effect on the manner of performing the work. Again, the inclusion of the many conveniences, which today make a home a joy to the busy housewife, in turn make the building superintendent's job a more complex one.

¶ It is with the idea of giving the contractor, engineer, or layman authoritative information on this important subject that this little volume has been published. The problems of the steel and reinforced concrete structures must be and are treated in separate volumes but this treatise has been designed to show, in as practical a way as possible, the working out of the erecting problems for the simpler forms of buildings. Every detail is given from cellar to attic, from electric wiring to plumbing and heating. The frame-house problem is taken up first, of course, as the problem is simpler. The mason work, framing, lathing, plastering, roof, outside and inside finish, stairs, hardware, and painting all come in for a proper portion of attention.

¶ In the discussion of brick and stone dwellings the city requirements are more carefully considered even as far as apartment and office buildings. Altogether, the work is exceptionally readable and thoroughly well done.

¶ The author has had years of experience in this field as an architect and speaks with authority. It is hoped that the volume will be found helpful to anyone who is interested in the development of proper building methods.

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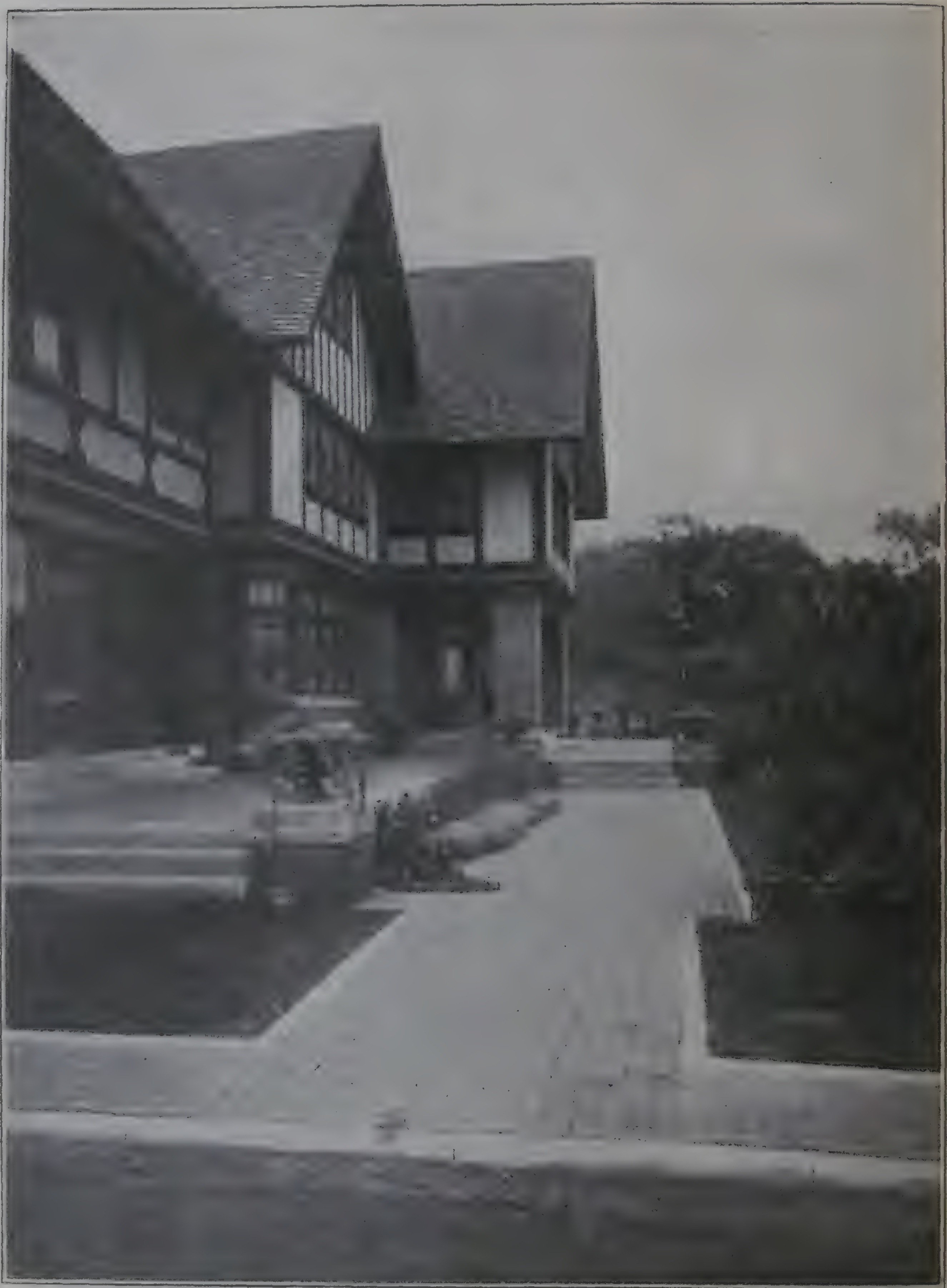


HOUSE AT CANTON, ILL.

R. C. Spencer, Jr., Architect, Chicago, Ill.

Paving Brick Walls: Stud Frame Above, Plaster on Metal Lath, Paneled by Undressed and Stained Boards: Red Shingle Tile Roof

BUILDING SUPERINTENDENCE

PART I

FRAME CONSTRUCTION

INTRODUCTION

Responsibilities of Superintendent. The superintendence of building operations is one of the most important and, at times, one of the most perplexing duties which an architect is called upon to perform. Plans may have been prepared with the greatest of skill and elaboration, and details may have been worked out to a marvel of perfection; and yet by the want of attention given at the proper time, costly mistakes may be made and results attained which are a source of annoyance and expense to the owner, and often a lasting discredit to both architect and builder. It is only by constant watchfulness and by the exercise of a thorough knowledge of common practices and materials, that these errors can be avoided, and it is the duty of the architect, as superintendent, and as a just and impartial referee between the owner and the builder, to acquire this knowledge and to exercise it freely and decisively.

The owner, who has secured the services of an architect, will naturally expect from him something more than the builder could have furnished. Superiority in matters of taste he will look for as a matter of course, and, beyond this, a superior knowledge of materials and construction, and an executive ability to handle men and direct the many forces which must be applied to obtain a certain and satisfactory result. The architect should possess then, as superintendent, a thorough knowledge of the materials at his disposal and should see clearly before him, with his mind's eye, the building which he proposes to erect. To do this, he must know how all the various elements of the building are to be assembled and molded into a complete whole.

To a familiarity with details, the architect must add such a quickness of perception and soundness of judgment, that it will be impossible for any bad work to escape his notice; and to this knowledge of the general principles of building, he must add an understanding of principles and possibilities far beyond that of the builder, so that he can foresee causes and effects and guard against any waste of effort or of time. In his position of referee, he must show such a familiarity with building matters that his judgment will be respected by both owner and builder, and he must have confidence that his opinions are correct. Having rendered a decision, he must stick to it, for any weakness or indecision will be quickly discovered by the workmen, and the architect will be discredited and very likely imposed upon. It will not do for him to trust too much to the generosity of the owner, or to the liberal intentions of the builder, for it is probable that both are at the same time trusting in the ability of the architect and the clearness of his foresight.

The preliminary remarks here made upon the duties and responsibilities of the superintendent will serve to bring before the student of architecture the importance of familiarity with ordinary practice. The young architect or student will rarely have an opportunity of gaining this knowledge by practical experience, and it will be necessary for him to depend in a great measure upon technical books for information he must possess. It will be the object of this paper to point out to the student, in a manner that can be easily understood, some of the ordinary methods of building construction, rather than the theoretically perfect methods, and to show as well some of the ways in which defective work and materials are to be discovered and avoided.

It will be assumed that the student has become familiar with the usual methods of drawing and construction from his previous work, and that he would be able, if called upon, to superintend the construction of the suburban house which is here used as a type. This does not mean that the erection of a dwelling is the easiest matter, for such is not the case; but this class of building has been chosen because there is greater opportunity for the comparison of results with practice—with the buildings in which we live—and also because it contains a variety of structural problems.

Relations with Owner and Contractor. It is important for the architect to have, as early as possible, a clear understanding of what is expected by the owner, and for the owner to have an equally clear understanding of what is due to him from the architect. The owner, in his implicit confidence and trust in the foresight of the architect, is likely to visit upon him the blame for particular failures of construction which could only be avoided by the care of superior workmen under the constant watchfulness of the builder or an ever-alert clerk of the works; and it is well for the architect to have it understood at the beginning that he cannot always be present and that he cannot in ordinary practice guarantee perfection of plan or execution, but that he will agree to give reasonable care and observation.

With the contractor it should be clearly understood at the beginning that the work is to be done strictly in accordance with the drawings and specifications, that the materials are to be as called for, the workmen to be competent, and the builder himself interested and capable. If any unfit material appears upon the site, it should be rejected at once and finally, for any laxity or indecision upon this point at the start will surely be taken advantage of, and will be a precedent for future indifference. Any work not done carefully or in accordance with the drawings, must be at once taken down, in the presence of the architect if possible, and any mistakes discovered should be noted before they are forgotten or crowded aside by other details.

With the foreman an understanding should be had at once that he is to work *with* the architect and not *against* him. It is poor policy for the architect to ignore suggestions made by the foreman, for if the latter is a thorough mechanic of ability and foresight, as the foreman of a building of any importance should be, he will often be in a position to save the owner from needless expense, and the architect from many of the vexatious conditions and minor complications which frequently arise in ordinary building transactions.

Familiarity with Site. Of prime importance to the architect in starting a new building is a familiarity with the site and with local conditions and customs; it will also be of advantage to him to make the greatest possible use of the time spent in preliminary visits to the locality, to observe what is being or has been done in the vicinity. The more familiar the architect is with local customs or possibilities, the more efficient will his supervision of that particular building become, through the rejection of practices which are bad and the adoption of those which are good. There are very few buildings from which the young architect cannot learn something, and it is an unprogressive builder who has not some particular method which will be new to the superintendent.

Familiarity with Drawings. Another essential, a matter of the greatest importance, is that the superintendent should have a perfect understanding of the drawings and specifications. If these have been prepared by the architect who is to superintend the work, an understanding is assured, but even in this case it will be necessary to consult the plans often, lest something be overlooked or confused with some other building which the architect may have in mind. Familiarity with the plans and specifications will also be of service in enabling him to look ahead, and to prevent many unintentional deviations which carelessness or lack of understanding on the part of the builder, or of the foreman upon whom will devolve many of the duties and responsibilities of modern building operations, might occasion, and which, once started, might seriously delay or damage the construction. The foreman, and the master builder himself, as well, should receive personal directions from the architect, and should be particularly instructed to look over the drawings carefully, and to report to the architect any discrepancies in figuring or any apparent difficulties of execution which either may discover, and all points not clearly shown or fully understood.

Self=Confidence. With this feeling of co-operation thoroughly established between the owner, the architect, and the builder, the architect will be in a position to decide any questions of difference with an assurance that his decisions, being fair and impartial, will be respected. Satisfied that his opinions are correct, he should announce his decisions promptly and impartially, and, his answer being once given, he must have the courage to maintain his position until proved to be in the wrong. Hesitation or a lack of confidence in his own judgment might affect the prestige of the architect, and might be taken advantage of.

Systematic Plan of Supervision. In following the construction of a building, the superintendent will find it of importance to adopt some systematic method in order to make sure that attention is given to the various details of construction at the proper time. If this is not done, many defects of construction and workmanship are likely to be concealed or built upon in such a way as to make correction impossible, or at the least inconvenient. To prevent this, the superintendent should make a point of going all over the building at each visit and examining carefully any work which has been done since his last visit. In this way he will not only guard against concealed defects but he will be able to time his next visit so that special operations, which he will be able to foresee, will receive his personal attention and direction at the proper time.

Inspection of Materials. One of the most important safeguards against defective building is the careful inspection of the materials as they are delivered at the building site, and the prompt rejection of any improper materials. These should be marked plainly, in such a way that it will be impossible to use them in the superintendent's absence without the mark being seen. If poor materials have been brought into the building, they should be rejected at once and, if possible, removed from the building site. If the contractor finds at the start that all poor materials will surely be rejected and that all work which is not properly done must surely be rebuilt, he will be careful that both workmanship and materials are maintained at the proper standard and, for his own sake as well as for the good of the building, he will keep on the building only workmen who prefer to do a good job rather than a bad one.

PRELIMINARY CONSIDERATIONS

Selection of Site. First in importance to the owner as well as to the architect is the selection of the spot where the house is to stand. To the owner the essentials will be the outlook and ease of access, and, at the same time, the appearance which the house will present from the various approaches, and the light and warmth of sunshine possible in the principal rooms. In almost all portions of our country a southern or eastern exposure is the pleasantest and should be the choice for the main rooms, that they may thus receive the morning sunshine and warmth in winter and avoid the intense heat of the afternoon in summer.

To the architect, less apparent but no less essential considerations present themselves in the practical aspects of the ground. In rocky or hilly country, besides the significance of the outlook, is the importance of placing the house so that natural advantages of slope and ledge may be profited by for driveways and yards.

Study of Soil. In every location the consideration of the character of the soil is of great moment. It may be rocky, or clayey, or sandy; it may be springy or well drained. The surest way to find out the actual condition is by digging test pits to the proposed depth of the cellar, but in many cases the appearance of the surface will give sufficient indication of the nature of the soil, while the presence of ledge may be detected by driving a rod into the ground to the depth of excavation. If the soil is rocky or clayey, we may anticipate trouble from water, which in rock or clay finds a way into the excavations, Fig. 1, and, having no way of escape, gradually rises until the pressure is sufficient to force a way through the cellar wall or concrete, in spite of almost any precaution which may be taken to exclude it. The only remedy is to give the water an easier way to escape than through the wall or cellar concreting; in towns where there are sewers this is an easy matter, as it is only necessary to secure a good connection with the sewer by means of suitable pipes, which must be started at a level lower than the cellar bottom, Fig. 2. This makes it necessary for the house to be set high enough so that the bottom of the cellar is well above the top of the sewer. If the house is in a locality where there is no sewer, water may be guarded against similarly by laying drains with a proper grade from the cellar of the house to an outlet wherever one can be found at a lower level. This can usually be done in a rolling country; but a cellar in clay

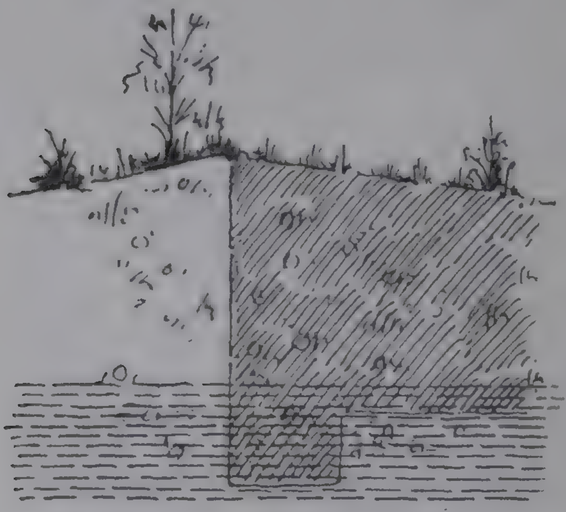


Fig. 1. Ground Water in Soil Excavation

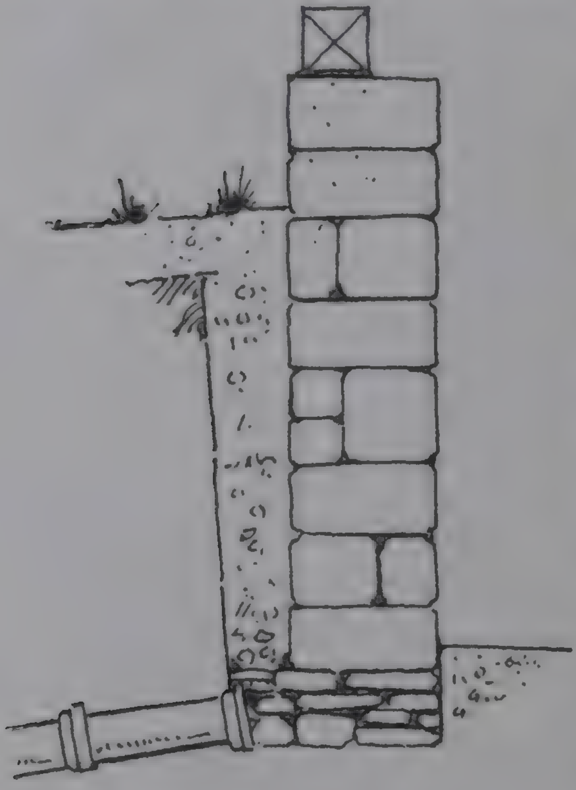


Fig. 2. Location of Cellar Drain

or rock in a level country is likely to be a continual source of trouble and should be avoided if possible. Most suburban towns afford some choice in house lots, so that often serious trouble may be evaded by a careful examination of the soil and of surrounding conditions before purchase is finally made. In sandy or gravelly soil hardly any extra precautions will be needed as the water is free to drain away through the sand and will have no tendency to run through the wall of the cellar. Even in sandy soil, however, it will be well to give the outside of the wall a coating of cement or asphaltum, care being taken to see that the whole surface is covered.

Description of House. The house which we will assume to construct is the same as that treated in detail in "Architectural Drawing", and we may suppose it to be erected upon a suburban lot not wholly level but with the usual variations of ground and aspect. The house is designed in the colonial style, Fig. 3, and comprises a large living-room, hall, parlor, dining-room, back hall, china closet, kitchen, pantry, and entry, on the first floor, Fig. 4; and five chambers with bathroom and stair halls on the second floor, Fig. 5. The attic is unfinished, and the basement contains a laundry with wash trays, a storeroom, and servant's water closet.

The living-room is finished in quartered oak, the dining-room in mahogany, the parlor, halls, and sleeping-rooms in white painted finish. The kitchen and service portions of the house are finished in North Carolina hard pine. The floors of the main house are of quartered oak in the first story and spruce in the second story; the floors of the service portions are of Georgia pine. The exterior walls are clapboarded and the roof shingled.

Drawings. The drawings upon which the contracts are to be based consist of a plan of each floor, a roof plan, and elevations of all four sides. Where the inside finish is at all elaborate, sectional drawings are made in sufficient number to show all of the rooms and halls. These general drawings, supplemented later by framing drawings and details and a carefully written set of specifications, represent the labor, materials, and methods to be employed. The necessity for a perfect familiarity with these drawings and specifications on the part of the superintendent is obvious, and has been already dwelt upon to some length, but a few words may well be

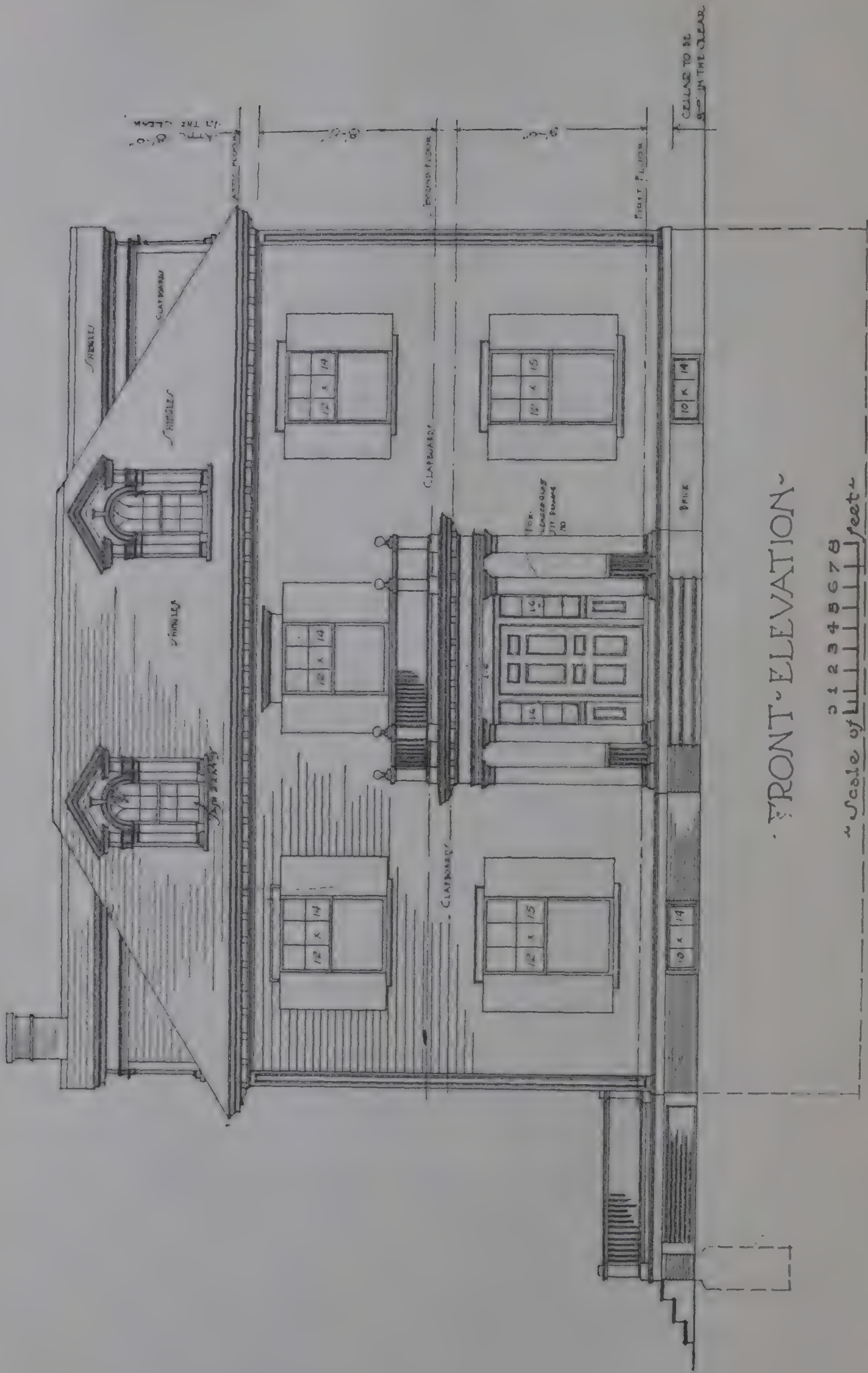
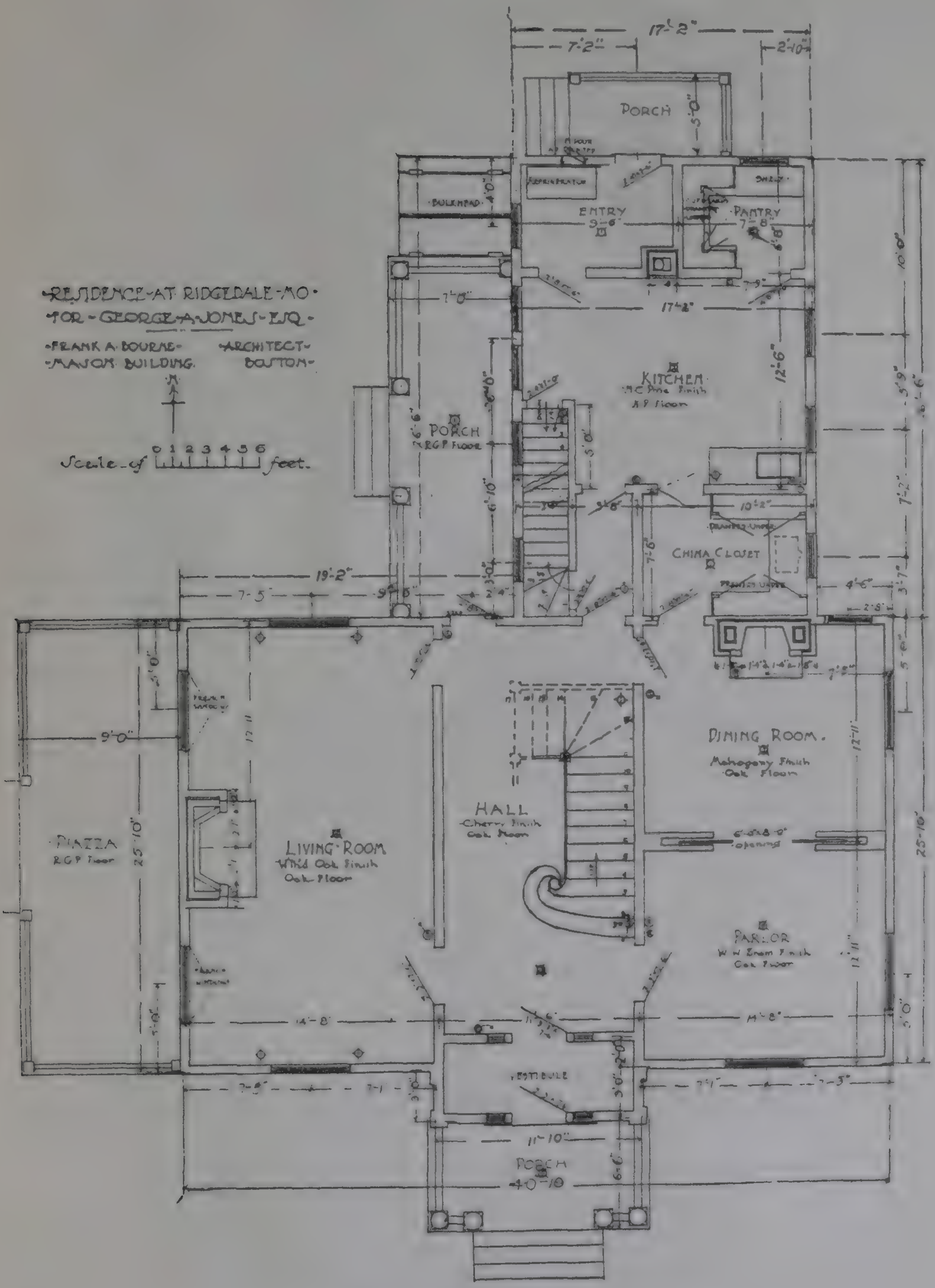


Fig. 3. Residence under Consideration, Designed for George A. Jones, Ridgedale, Missouri

Courtesy of Frank A. Bourne, Architect, Boston, Massachusetts



-PLAN-OF-FIRST-FLOOR-

Fig. 4. Plan of First Floor of the Jones Residence

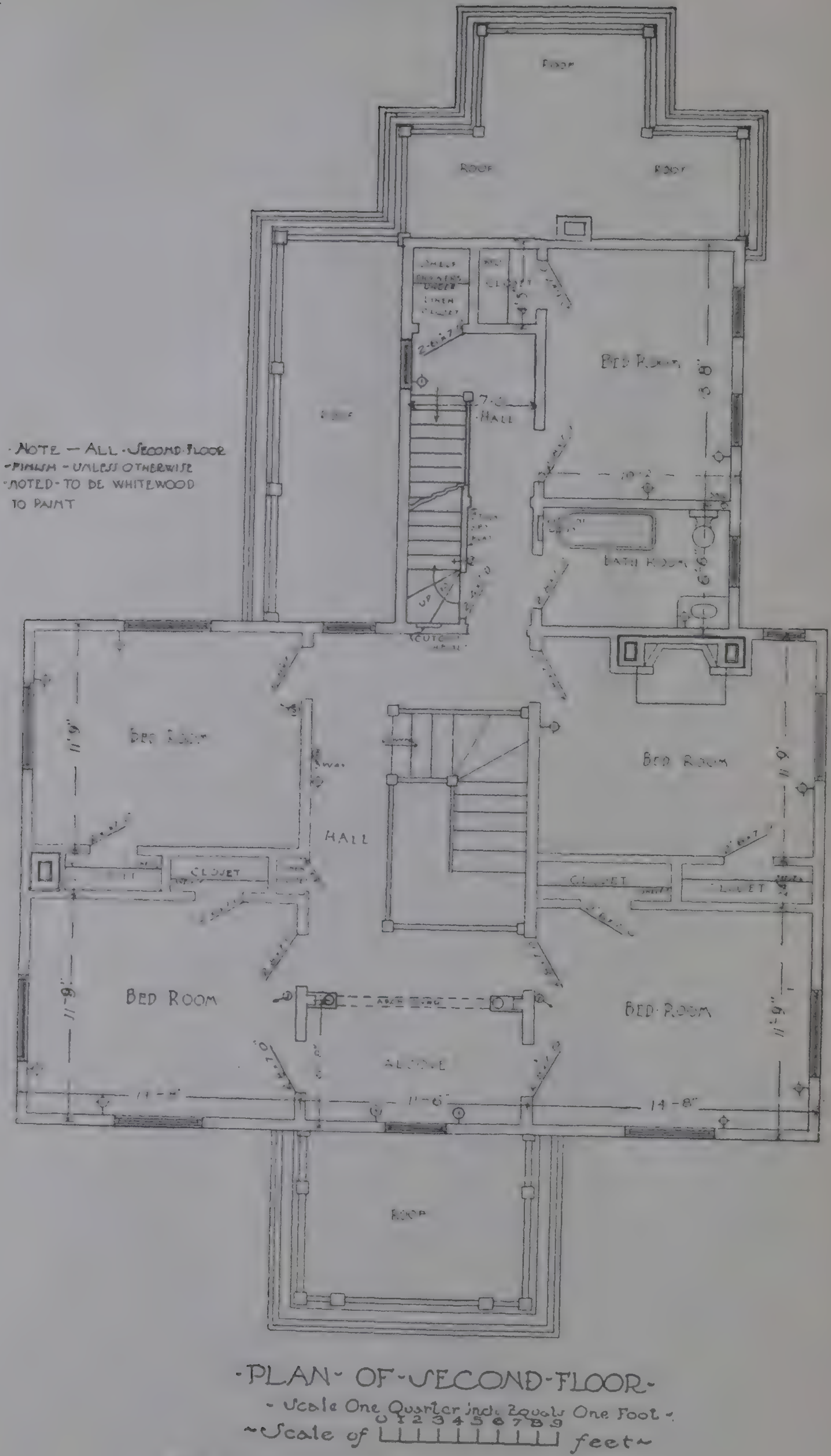


Fig. 5. Plan of Second Floor of the Jones Residence

given here with regard to the same precautions on the part of the owner and of the contractor.

Study of Plans and Specifications of Value to Owner. It will be to the interest of the owner, if he will take the time and trouble while the drawings are yet being made, to consider, with the help of the architect, the various details of construction and furnishing, and to become familiar with the drawings, that he may clearly understand just what they are intended to represent. By comparing sizes of rooms, doors, stairs, and other fixtures, as drawn, with houses already built, he will be able to satisfy himself that the house, when finished, will be according to his wish. The specifications may to good advantage be examined at home, that he may receive suggestions from the various members of his family, and modifications can then be readily made to meet individual preferences and tastes. Careful study of this kind will be of great value to the owner, and will often avoid later expense in altering work which, in the absence of particular instruction, would have been carried out in the usual way; and the architect will find that time spent in helping the owner, and also the contractor, to a thorough understanding of his drawings, will enable him to carry out the work with greater satisfaction to himself and to all concerned. With a complete and accurate set of drawings and specifications, a fair and equitable contract, and a thorough understanding of these instruments on the part of all the parties interested, we are well equipped to begin operations at once.

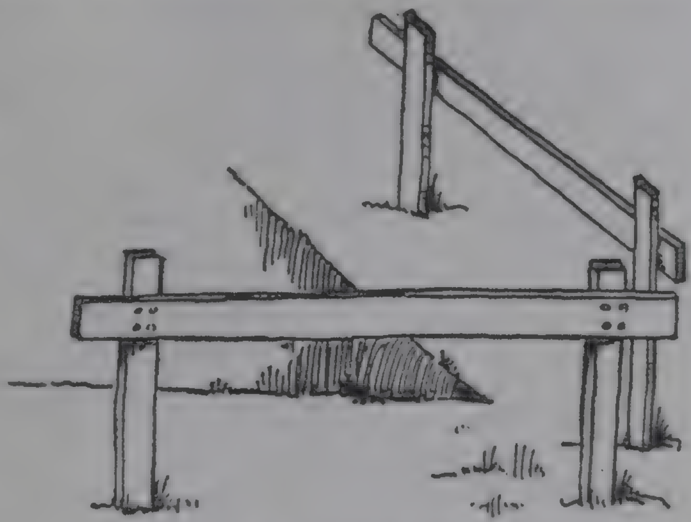


Fig. 6. Batter Boards

Staking Out. Upon the signing of the contract, arrangements are usually made for the architect and the contractor to meet upon the ground and lay out the building. The contractor for our house is required by the specifications to employ a civil engineer to lay out the work and set the batter boards. These consist of boards 6 or 8 feet long, as the case may require, securely nailed to joists which are firmly set in the ground at the corners of the cellar, Fig. 6.

Two boards are needed for each angle, and they are set 4 or 5 feet away from the line of the wall so as not to interfere with the excavation or with the laying of the cellar wall. Before proceeding to erect the batters, the position of the house will have been fixed by the engineer, by setting a stake at each corner, into the head of which is driven a nail marking the exact corner as indicated by the figured plans. This is often omitted but it is advisable as it gives a figure which corresponds to the dimensions printed on the plans, and any error can be more easily detected than when the lines for the walls are drawn. As soon as the corners of the house have been definitely located, the stakes for the batter boards are set and securely braced, and upon these stakes the batter boards are nailed with the top of the board at some given level, usually the top of the cellar wall. Between these boards, lines are stretched coinciding with the lines of the building as given by the small stakes; and when the lines are accurately drawn, notches are cut in the top of the board to hold and mark the place where the string belongs. If the stakes first put down were to represent the outside line of the sill, as is often the case, we must measure out and make a second set of notches for the underpinning, and back from this line measure the thickness of the wall, Fig. 7. It is often the custom to drive nails into the top of the batter boards, to which the lines are tied, but this is not a good practice, as the nails are likely to be pulled out of the board before the walls are finished, and are very likely to be driven in again in the wrong place. In addition to setting the batter boards at a given level, it is always well to establish in some permanent place, as upon the top of a neighboring ledge or on a stake firmly set and well out of the way of all building operations, a datum level or "bench mark", as it is commonly called, from which, at any time, the levels of the work may be given.

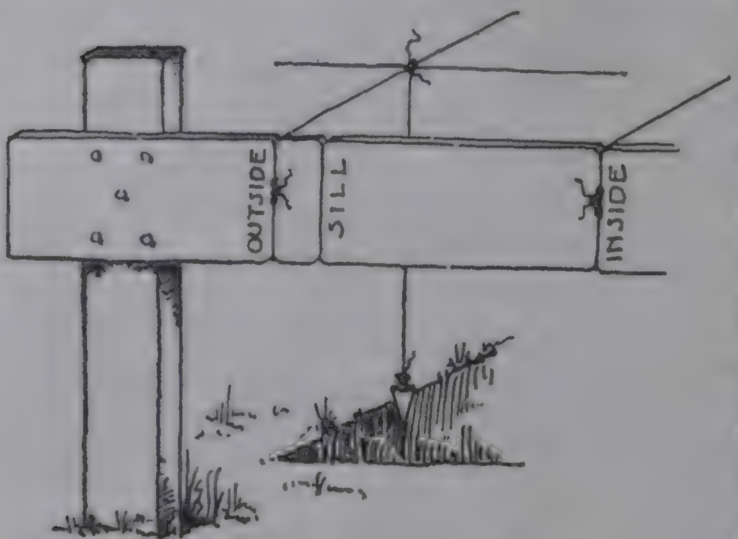


Fig. 7. Use of Batter Boards for Staking Out Building Foundation

Disposition of Materials. Before leaving the grounds it is well to instruct the builder where he can best deposit the material which will come from the excavations; and to place this to the best advantage, it is necessary to determine in a general way the position of the driveways or paths, and also to have a thought for future improvements and for the required drainage system. Unless this matter is taken up at this time it is very probable that the earth from the cellar will be left so near the excavation that it will have to be driven over or walked over during construction and then finally moved away to its destined use, as it should have been in the first place. The gravel will be needed for the driveways and paths, and space for this should be found not far away from the house; as the loam will be used where it is desired to have a good growth of grass and flower beds, this should be piled at the front of the lot, ample space being left for the convenient handling of timber and other materials. It will be necessary to consult the builder with regard to both this and the depositing of earth, that he may not later complain he has been hampered by lack of proper space.

CELLAR WORK AND FOUNDATIONS

DRAINS AND CESSPOOLS

Drains for Cellar Floor. The next visit finds the excavation of the cellar well under way. The earth has been removed, care being taken to make the outside walls conform to the dimensions of the foundation, and the cellar dug to the bottom for a great part of its extent. We proceed at once to examine the nature of the soil, and we find that while it is in the main a good coarse gravel, there is evidence toward the bottom of a clayey deposit which will hold water; and, indeed, in the trenches directly under the wall, which are to be 18 inches below the bottom of the cellar, water is standing in several places. Remembering that in the specifications it has been foreseen that the bottom of these trenches should slope to a corner of the cellar, we direct that the slope shall be made toward a hollow in the lot and that the trench shall be extended until it meets the surface of the ground in the hollow some 30 feet or more from the house. This trench, as well as the slope of the trench under the wall, we must make with a very slight pitch, lest the run of the water should wash away the soil under the wall and cause settlement; and for greater security we must see that the lower foot of the wall which, according to the specifications, is "to be laid dry in the trenches", is *well laid* and not dumped or thrown in, Fig. 8. These stones should be neither large enough to choke up the trench and prevent the flow of water through it, nor so small as to be crowded into the ground by the weight of the walls over them. In any case, it is advisable to anticipate possible settlement by ramming the first layer of stones well into the bed of the trench. Where the soil seems to be somewhat soft or the weight of the building is greater than usual, it may be desirable to start the walls on broad footing stones carefully bedded upon the bottom. In this case it will be necessary to make the drain entirely outside of the wall, where it may be built of tile or stones. Indeed, but for the added expense of excavation and the increased cost of large footing stones, this method would be always preferable, Fig. 9.

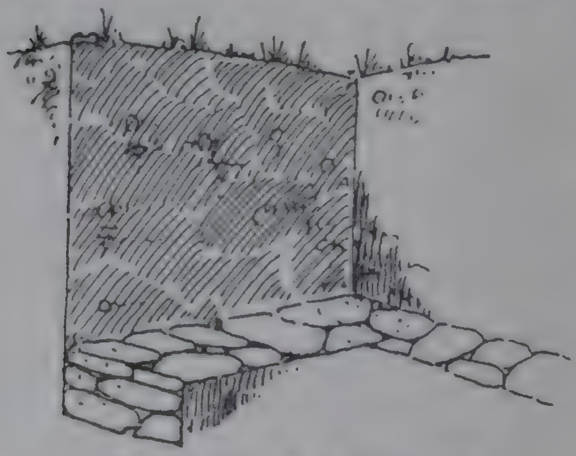


Fig. 8. Dry Wall in Trench

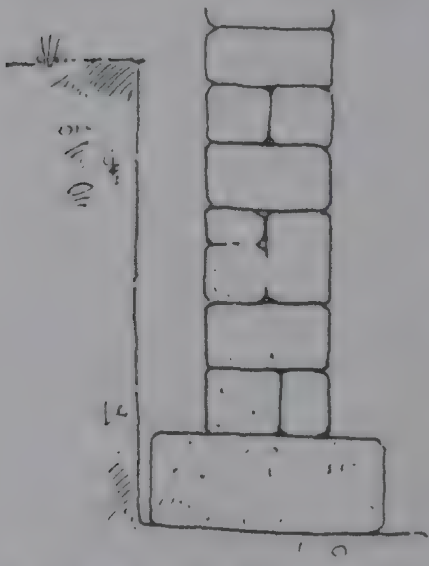


Fig. 9. Use of Footing Stone

If on the completion of the excavating there should be found any wet spots in the cellar bottom, these must be connected, by trenches filled with stone chips, with the main drain under or outside the wall, and in extreme cases the whole cellar bottom under the concrete should be filled with loose stones to a depth of about one foot.

Cesspools. In connection with the excavation of the cellar, we should take up the matter of a cesspool, provided there is no sewer connection available. In locating cesspools we must see that they are placed low enough to allow the drain from the house to have a good pitch. This drain will be of vitrified earthen pipe and should be laid at least 3 feet 6 inches below the surface, with an even pitch and with the bottom of the trench hollowed out where the hubs of the pipes will come, so that the pipes will lie flat in the trench.

Great care must be taken in jointing the pipes to make sure that the cement is scraped off the inside, since a projection would catch a portion of any solid matter which might pass through and the pipes soon become filled.

In building the cesspool we have a choice of methods—the leaching cesspool and the tight cesspool. In a great many cases where all danger of contamination of wells is obviated by a city or town water service, the cheaper method of a leaching cesspool may be adopted.

Leaching Cesspool. This consists of a circular excavation 8 or 10 feet in diameter and deep enough to reach to good leaching or absorbent earth. It is lined with a dry wall of stones laid with open joints, and arched over on top with stone or brick forming a dome made water-tight, in the center of which should be set a stone or an iron manhole cover, Fig. 10. This may be finished at the level of the ground or kept low enough so that it can be sodded over. In good coarse sand or gravel a cesspool of this kind will dispose of the sewage of a house for a great many years, but eventually the pores of the earth will become filled with the deposits and leaching will no longer take place. An effective remedy in this case consists in making an outlet to which a series of pipes laid with open joints may be connected, to distribute the waste throughout a system of branches laid about 12 inches below the surface, where it will be absorbed and purified by the soil and growth.

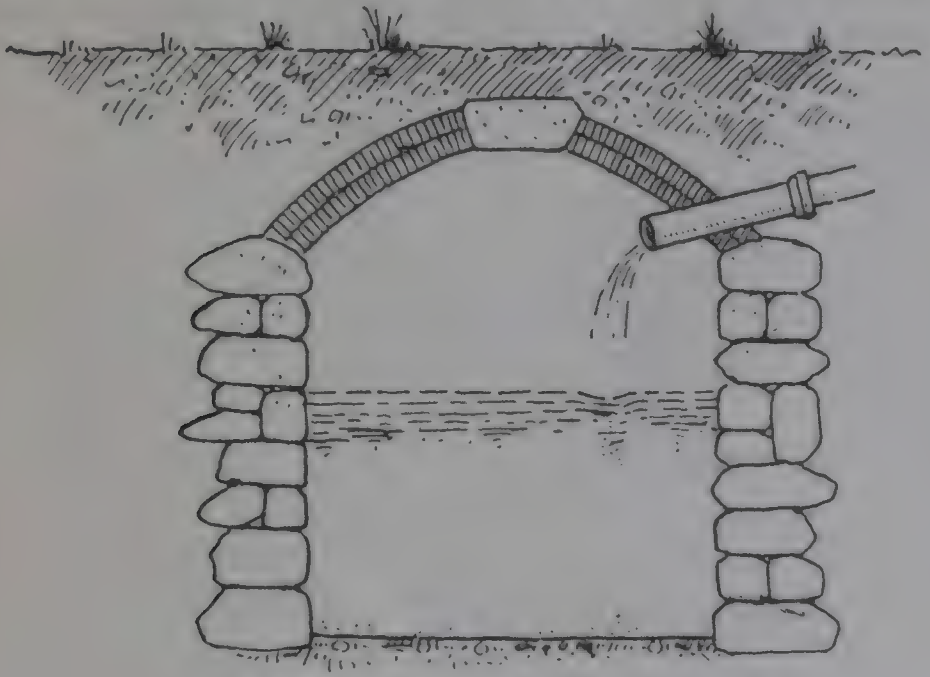


Fig. 10. Section of Leaching Cesspool

Tight Cesspool. The other form of cesspool is what is known as a tight cesspool. It is constructed of hard brick and is usually made about 6 feet in diameter and 6 feet deep from inlet with walls and dome 8 inches thick and the bottom 4 inches thick, the whole cemented inside and outside and made perfectly tight, Fig. 11. This cesspool will retain the whole of the deposits and must be either frequently emptied, or an outlet made of open-jointed pipe as described in connection with the leaching cesspool. Such an outlet should be below the level of the inlet and should have a bend turned down below the surface so as to remain in the clear water which will be found under the scum of the surface. We find by the specifications that our architect has adopted a clever combination of these two methods by building two cesspools, one of which is a small, tight cesspool which will retain all the solid and putrefying matter and which is connected by an overflow pipe with a leaching cesspool built as described above. By this arrangement the tight cesspool will receive all of the solid matter which may be in the sewage and will hold it where it can be cleaned out at stated periods; the overflow, being of a wholly liquid nature, will pass into the leaching cesspool in a comparatively clear state and will be absorbed entirely by the surrounding earth with no perceptible contamination.

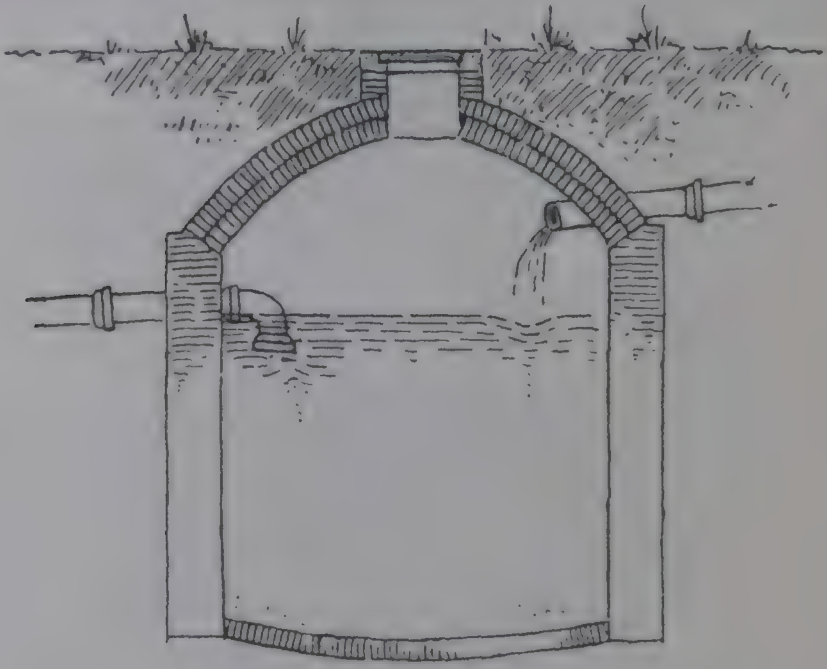


Fig. 11. Section of Tight Cesspool

Dry Wells. As a part of the drainage system we must provide for the distribution of the rain water from the roofs. If our house were connected with a sewer, we should simply connect the conductors properly with the main drainpipe in the cellar; but since we do not want this great amount of water to run into the cesspool, we will lead it away from the house by means of earthen pipes running from the bottom of the conductors to dry wells. These are excavations some 3 or 4 feet each way, filled with loose stones which are piled around the end of the drainpipes while the whole is covered with the grading, Fig. 12. The location of these wells will be determined by the position of the conductors, but they must be at least 8 or 10 feet from the cellar wall, and farther away if there is any danger of the water finding its way back to the cellar. The waste from the laundry trays, being of a comparatively clear nature, we will dispose of in the same manner.

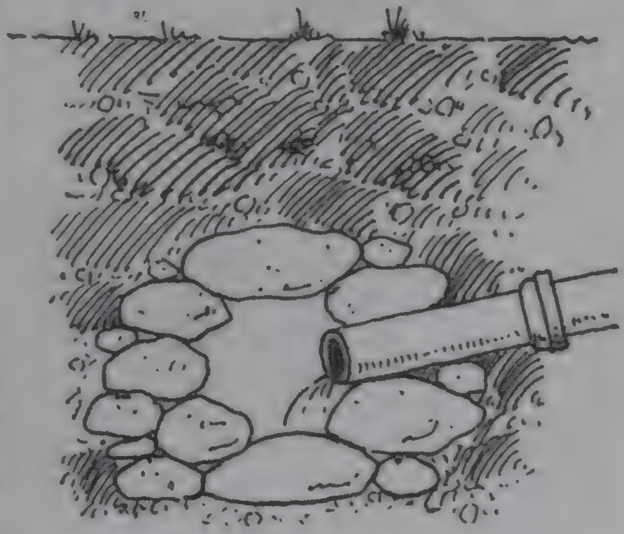


Fig. 12. Section of Dry Well

CELLAR WALLS

While it is necessary to consider the matter of drainage at this time, the actual work of building the cesspools and laying the drain pipes is usually taken up at a later period, and the whole of our energy at this time should be directed toward the building of the cellar walls. Already the timbers for the frame are being delivered, and the contractor for the carpenter work is filled with forebodings lest he have no wall to put his sill on when the first floor is framed. We direct the mason to build the cellar walls with all the speed that he can, "consistent with good workmanship", and set ourselves the task of following him up sharply to see that this is done.

Quality of Stones. The greater part of the stone for the cellar walls has been carted to the lot and we shall do well to look it over with the mason, pointing out to him that many of the boulder stones are too round and should be split before being used, while some of the more slaty stones, which appear to have been recently blasted, may have cracks in them which will allow the water to soak in. This may be detected by striking the stones with a hammer to judge of their soundness by the clearness of their ringing. The stones, upon the whole, are a good looking lot, and it remains only to see that the walls are properly constructed.

Method to Be Avoided. In the first place the walls must be built entirely free from the bank so that they are self-supporting, Fig. 13, and give besides an opportunity of cementing the wall on the outside, as called for. This is a thing generally neglected, and yet it is far more important than that the inside of the wall should be smooth and handsome. The ordinary careless way of building the cellar wall of a country house, is to lay the wall up to the top of the ground without mortar, stones of varying thickness being brought to a face on the cellar side, with the "tails" of the stones in irregular projection on the outside, some partly resting against the bank and others barely filling out to the required thickness. The whole is finally smoothed over on the inside with a thin smearing of mortar, Fig. 14. This is a method which should be avoided for many reasons. In the first place, a wall of this kind is little or no protection against water, for the uneven projections on the external face serve to catch the water which runs down on the outside and to lead it into the inner face, where the thin pointing of mortar is very little protection. Then, too, any movement such as frost in the ground tends to overthrow the wall by reason of the long stones which tail into the ground, and often bear upon the soil in such a

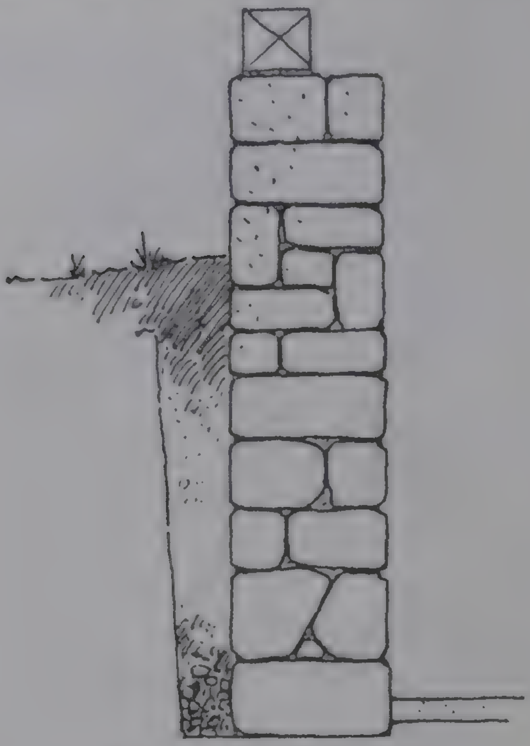


Fig. 13. Good Cellar Wall

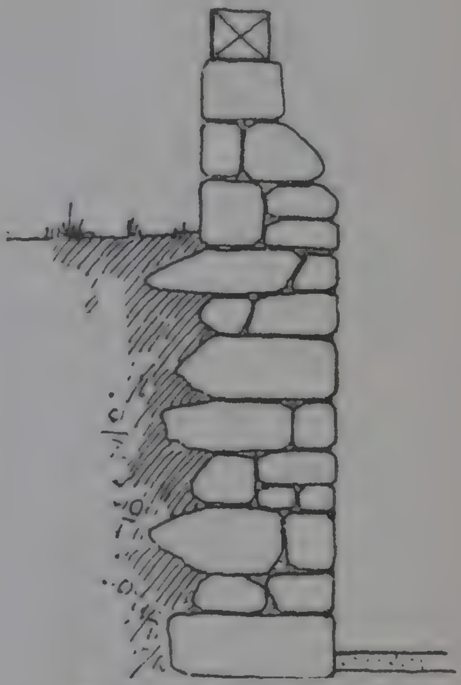


Fig. 14. Poor Cellar Wall

way that any settlement or heaving of the soil will open cracks and cause the wall to bulge inward, as is often seen in country cellars. In reality it is more important to have the outside face of the wall smooth and impervious than the inside face. Satisfied that the stones which are being delivered are suitable for our wall, we shall need to give our attention mainly to the construction, to the mortar and bonding, to the solidity, and later to the pointing.

Mortar. The specifications require that all stonework below ground shall be laid in Portland cement mortar 1 to 3. This means 1 part of cement to 3 parts of sand, and makes a strong mortar. The portions which show above ground are to be laid in "half-cement" mortar, which we interpret to mean *equal parts* of cement and lime, and not *half* as much cement as lime, as some contractors will claim. This proportion of cement and lime with about 8 parts of sand will make a proper mixture; it should be thoroughly mixed as tested by the evenness of color and the smoothness.

For a wall particularly exposed to dampness, it would be well to use a stronger mortar than this, and to omit a large portion of the lime, only enough being retained to give a degree of smoothness to the mortar under the trowel. A proportion of 1 bag of Portland cement, 1 barrel of sand, ½ pail of well-slaked lime putty will make a strong mixture, and one that works easily. A workman's mixture which closely corresponds is measured by the shovelful: viz, 10 "shovels" of cement, 30 "shovels" of sand, and 1 "shovel" of lime.

Lime. In slaking the lime for mortar it is important that the water, in the proportion of 1½ barrels to 1 barrel of lime, should be added in as large quantities as is practicable, since putting the water in by bucketfuls and stopping to stir the mixture each time, tends to chill the lime which is already beginning to heat. After slaking, the lime must stand as long as possible before being mixed with sand, and the cement should not be added until the mortar is needed, since it will set in a few hours. To be of good quality, the lime should be free from cinders and clinkers; it should be in hard lumps and have little dust. It ought to slake actively and entirely, making a fine soft paste with no residue or "core". Lime should always be slaked in a pen built of boards, never on the ground or in a hollow in the sand. A pen about 4 feet by 7, and 10 inches deep, is large enough to mix a cask at a time.

Some kinds of lime when slaked leave a residue of stones and gravel, and when this is the case, instead of having the mortar made in the same box in which the lime was slaked, the mixture is thinned with water and is run through a fine sieve into another box. If Rockland lime is used, as is specified in our case, this operation will not be necessary.

Sand. The sand used should be sharp and free from dirt, loam, or other impurities. To obtain this, it is generally necessary to screen the sand. For our purpose a rather coarse sand will make the strongest mortar. It must be carefully inspected and in case of any doubt should be tested for purity. One test consists in putting a handful into a dish of water; any dirt or impurities will at once rise to the top as the sand sinks. Another test is to squeeze a handful of wet sand; if upon opening the hand, the sand retains its shape and soils the hand, it probably contains loam or clay and should be rejected; if it falls down loosely without staining, it is probably clean and good. The presence of fine loam in the sand will make the mortar work more easily and for that reason it is sometimes used by unscrupulous builders.

Cement. There are many brands of Portland cement, the kind called for by the specifications, and they are so well known that for ordinary purposes it is only necessary to see that the casks bear the name of the specified brand, and that the cement is fresh and has not become crusty from absorbing moisture. In case of doubt, simple tests of the setting quality and soundness may be made by the superintendent. For the initial set a small amount of clear cement may be mixed with water enough to make a stiff mortar, and the time noted which is required for it to set hard enough to support without indentation a wire $\frac{1}{12}$ inch in diameter under pressure of a $\frac{1}{4}$-pound weight. Good cement should not harden to this extent in less than 30 minutes.

To test for soundness, mix some cement with a little water in several pats about $\frac{1}{2}$ inch thick and 3 inches in diameter, running to a thin edge. After these pats have been kept under a damp cloth for about 24 hours, place some under water and leave some exposed to the air for a few days. If the cement dries in the air with a light color and free from cracks, and sets under water with a darker color and free from cracks, it may be considered of good quality; but if any one of the cakes cracks or becomes twisted and bubbly, it shows a quality of cement which is inferior and should be rejected. Cement must be kept in a dry place, for a little moisture will cause it to set and it will soon become worthless.

Construction of Wall. Upon our next visit, we find that the trenches all around the cellar have been filled and a portion of the wall laid, starting from the corner and running some ten feet in both directions. Our first care is to examine the lines by which the work is being laid up. We note that each line is tied to its proper notch on the batter boards and that the men are working to plumb lines hanging at intervals from the long lines, Fig. 7, using the stones about as they come to hand, the only preparation being to square the too irregular ones, to make a face on them by the use of the stone hammer. We caution the mason to level off the wall about every two feet, Fig. 15, and to keep the horizontal joints as near to a level as possible. We also call his attention to the clause in the specifications which stipulates a bond stone in every 10 square feet of wall, and we carefully examine the wall already built to see if this has been done. In a wall such as we require, that is, one with practically two faces, there is often a tendency to build the two faces with long narrow stones and to fill in between with small stones which are put in nearly dry with a little mortar on top to show well. Such a wall has an appearance of strength on the faces, but under a heavy load may fail from lack of bonding. To detect this defect in a wall already built, but before the mortar has set, a very useful instrument is a steel rod about $\frac{3}{16}$ inch in diameter and 4 feet long. Thrust down into the center of the wall, this will show at once whether the stones are laid to overlap each other or not, and also whether the stones in the center are well bedded or not, as they will rock and jar when struck with the rod if not thoroughly bedded. No stone should be set with a depth from the face of less than 6

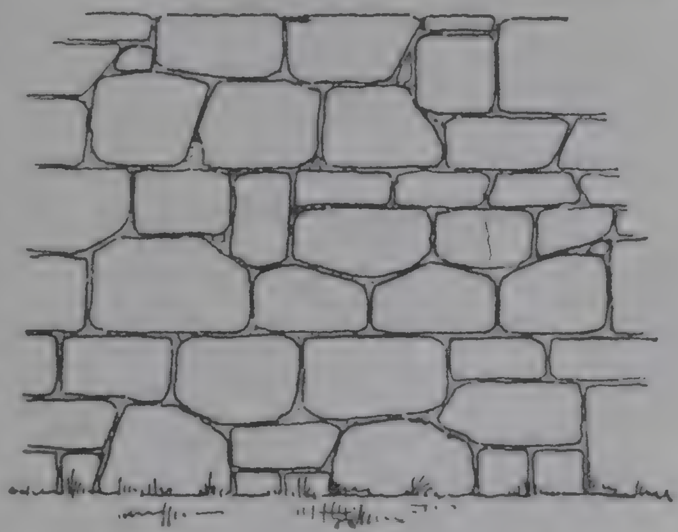


Fig. 15. Rubble Wall Leveled Off

inches, and all stones should be laid so that their split surface is horizontal, breaking joints in the length of the wall, as well as through and through, and all angles should be bonded alternately, the largest stones being used for the corners, Fig. 16.

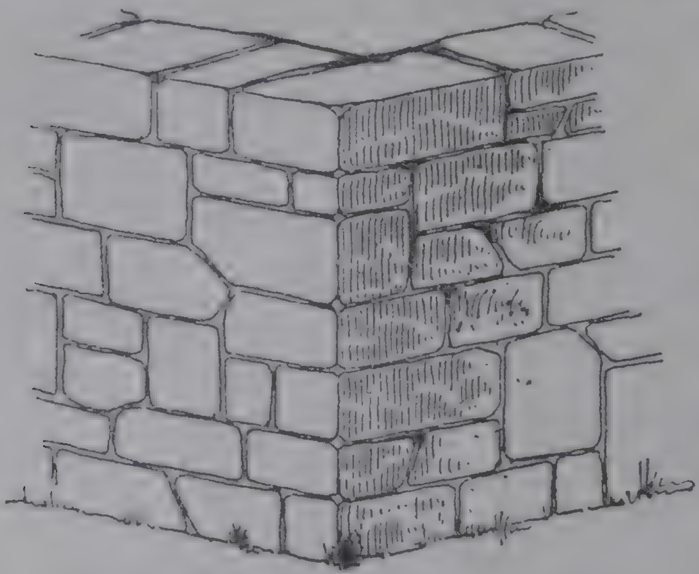


Fig. 16. Rubble Wall Showing Corner Construction

The corner which has been built we find to be well bonded, as the first corner of any wall is likely to be when stones are plenty and near at hand—it is the last corner of a cellar wall which will need the sharpest watching—but about six feet from the corner we discover a line of vertical joints which runs irregularly but continuously through four or five courses, *A*, Fig. 17. We call the man who is working upon this part of the wall, and point out the defect to him with instructions to take down the wall until he can bond over the second course, and we caution the foreman to watch sharply against this sort of construction. Another bad practice which some masons encourage is that of filling the spaces between the larger stones with chips or pebbles, put in dry and then smeared over with mortar more or less carefully worked into the seams. This kind of work is easily detected by use of the steel rod, which we can feel moving the stones if they are poorly bedded. The right way is to settle each stone, no matter how small, into a bed of mortar, either by rubbing with the fingers or by tapping with the trowel or hammer. In heavy work all large stones should be set with a derrick, for in rolling the stones up to their places on

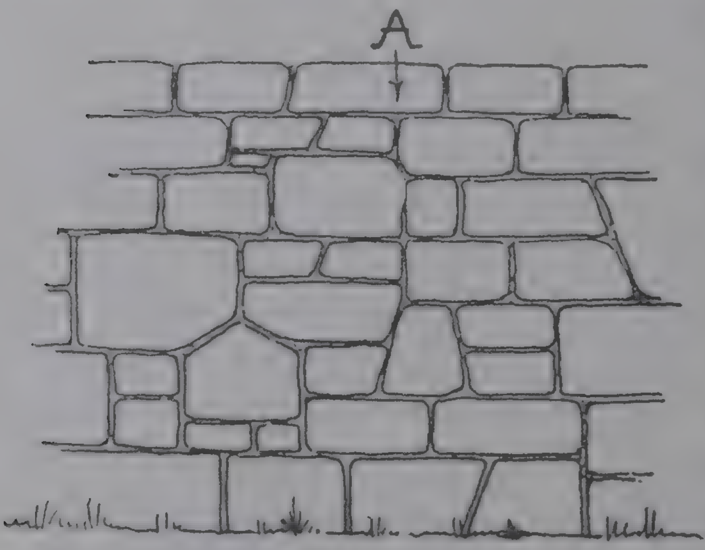


Fig. 17. Careless Wall Construction. Note Straight Joint *A*

planks set up against the freshly laid wall, there is not only danger of shoving the wall out of plumb, but the bed of chips and mortar which has been prepared is sure to be torn up, and there is no certainty that the stones are properly bedded. Satisfied with the work which has been done so far, we give orders that the filling in against the walls be done with coarse gravel or broken stone, well puddled with water or settled by ramming.

Concrete Foundation. The superiority of concrete footings and foundation walls, now universally recognized, has resulted in the exclusion of other materials in first-class work. Rubble and brick are used only where concrete is abnormally expensive or rubble very cheap and accessible. Forms for concrete should be carefully inspected for width, height, alignment, strength, and tightness. When the forms are removed and before the walls are plastered, the work should be inspected again and weak spots should be repaired.

Underpinning. The next visit finds the cellar wall complete up to grade and the excavation filled in to the natural level of the ground. While we have no reason to suspect that our instructions have not been followed with regard to facing the wall on both sides, we nevertheless have recourse to the steel rod. Thrusting it down alongside the wall at intervals, we do not find any projecting stones, and as the digging away of the filling in several places shows that the wall is properly cemented on the outside, we feel reasonably sure that the wall is built according to contract. We next take up the question of the underpinning, the portion of the cellar wall above ground which, being visible, must be considered from the point of appearance as well as of strength. A variety of materials may be used for the underpinning. Long pieces of granite or freestone in one or more courses are often used; sometimes an 8-inch brick wall is built upon the stone of the cellar; often the wall already built below ground is continued up to the sill, except that above ground, the face joints, instead of being carefully filled are left without mortar for about $\frac{3}{4}$ inch from the surface, to be filled later with Portland cement mortar, colored as preferred and rubbed with a tool made for the purpose to give either a concave, V-shaped, or raised joint.

It is important to see that the underpinning is carried up to the sill the full thickness of the wall, spaces being left for girders, and the top carefully leveled off at the bottom of the sill.

FRAMING

Sills. While the walls were being built, the carpenters have been at work framing the house and they are now ready to lay the sills and put on the first floor beams. The preparation of the sill consists in halving and pinning together at the corners, Fig. 18, mortising for the door and window studs, and notching out for each floor joist about two inches down into the top of the sill. The sill should be well painted on the underside as a protection against moisture from the wall, but unpainted elsewhere to allow drying out, and it should be set in a thick bed of mortar. As our sill is to set back two inches from the face of the wall, we shall have a chance to point up with mortar along the outside edge to be sure that there is no chance for cold air to get into the floors at this point.

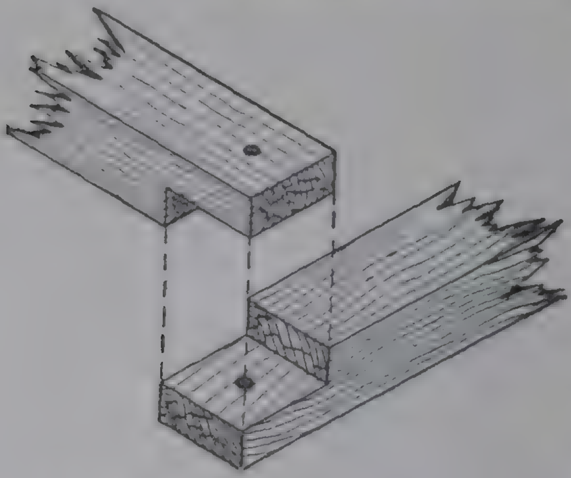


Fig. 18. Construction for Corner of Sill

Custom allows much variation in the size of the sill, 6×6 inches being the most common size; 6×8 inches is called for in our case, and sometimes the sill is made 6 inches by the depth of the joist. Where large sizes of timber are easily obtainable, this last method is to be recommended. In the first place, the greater depth of timber will span all openings that are likely to occur in the cellar wall, and, besides, the equal depth of the sill and joists leaves no space between the cellar and the vertical wooden wall and prevents, without recourse to brick filling, Fig. 19, the circulation of fire or vermin. The sill may be bolted to the wall, but this is not usual except for light framing in exposed situations.

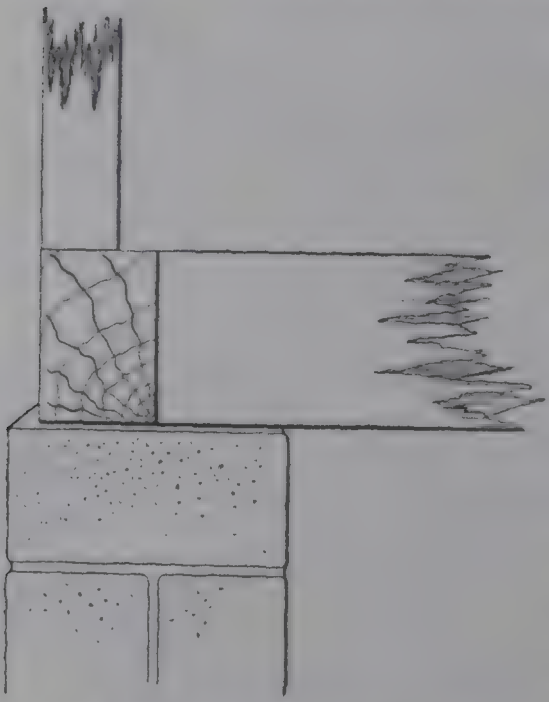


Fig. 19. Proper Construction for Sill on Wall

Girder Supports. After the sills are set, the next timbers to be put on are the girders which carry the inner ends of the floor beams. They are generally set under the bearing partitions of the house and supported by brick piers or iron columns in the cellar.

Brick Piers. Since the piers or columns are not usually set until after the heavy floor beams have been put on, as they would be in danger of being knocked over in the handling of the heavy timbers, the timbers are in most cases supported by shores until the piers are built. Piers of the height of an ordinary house cellar should be 12×12 inches, spaced, according to the size of the girders, from 7 to 9 feet apart.

Iron Columns. Where available, iron columns may be used as a good substitute for brick piers. They take up less room and are more easily and quickly placed. For ordinary cellar work, there are in the market columns made of wrought-iron pipes, filled with a carefully prepared cement concrete, which cost less than brick piers. These columns come in convenient lengths, fitted with a cap and base, ready to set and secure to the timber. From 3½-inch to 5-inch sizes are large enough for house work.

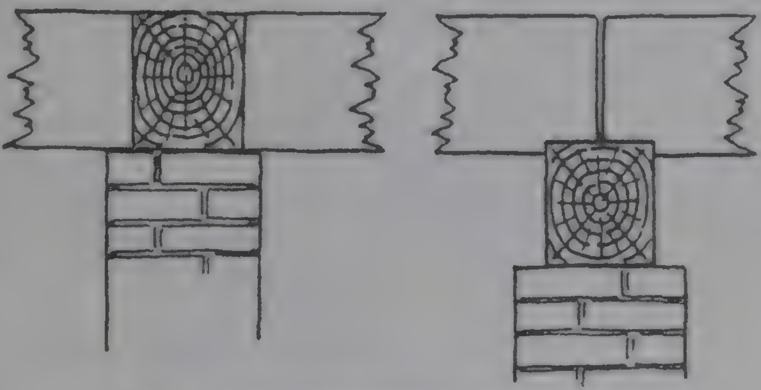


Fig. 20. Diagrams Showing Typical Flush and Drop Girders

Girders. The girders are usually 6×10 inches or 8×10 inches for the floors of a wooden house—in our house 8×10 inches. In their vertical position, the girders may be set flush with the floor timbers, in which case each joist is framed into the girder, or they may be dropped to allow the joists to rest on top, usually notched an inch into the girder, Fig. 20. The advantages of the flush framing are that the shrinkage of wood at each end of the joists is equalized, that the circulation of fire by means of the interior partitions is prevented, and that the girder does not take headroom out of the cellar. The advantages of the dropped girder are that the full strength of the girder is available, and that it is possible to run hot-air and other pipes up in the partitions without cutting the girder.

If flush girders are used, the position of mortises, as well as the position of the mortises in the sill, should be examined by the superintendent to see that the openings framed for chimneys, stairways, etc., are correctly laid out according to the framing plans. Obvious errors will, of course, be easily detected, but it will save much annoyance later if every mortise is verified before the floor is put on.

First or Rough Flooring. After the girders are placed the floor timbers may be set. These are usually 2 inches in breadth and for our house are 10 inches deep. Upon these joists is invariably laid, in the East, a rough floor of ⅞-inch boards either of spruce or hemlock, upon which the workmen can move to carry out all subsequent operations. It has been the custom in the West to omit this under floor, but the saving in expense is very slight and the benefits of the double floor are many. In the first place the under floor stiffens the building perceptibly; then it is of great convenience to the workmen, and allows the laying of the upper floor to be put off until the very last thing. This is an important consideration in these days of bare floors and has led to the adoption of the rough under floor generally. It is a good plan to lay this floor diagonally with the joists, as this greatly stiffens the building and gives a more even surface upon which to lay the upper floor.

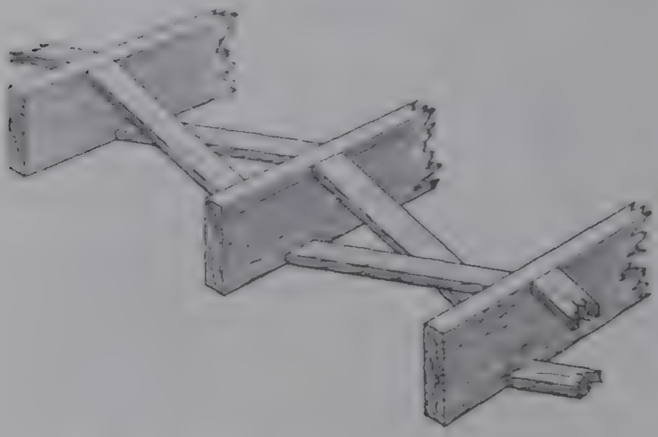


Fig. 21. Proper Method of Bridging Joists

Bridging. As soon as the rough floor is laid, and before this if the boards are to be laid diagonally, the floor beams must be bridged, or trussed as it is sometimes called. This consists in cutting in diagonally between the joists, strips of wood which are nailed securely top and bottom and cross each other between each two timbers, Fig. 21. Some carpenters reason that a piece of plank cut in vertically between the joists will serve the same purpose, but this is not so. If the floor is laid square across the joists, the usual way is to take up a board along where the bridging will come. The superintendent should make sure that the bridging is well fitted, thoroughly nailed, and continuous from side to side.

Exterior Framing. Next in order comes the raising of the exterior vertical frame, and in this operation we have a choice between two principles. The first and more common method is called the "full frame" or "braced frame" and consists, first, in erecting at the angles of the building, posts 4×6 or 4×8. Between these uprights, at the level of the floors, are then run horizontal girts which receive the joists of the second floor and into which are framed the door and window studs. At the top of the wall a plate is set in a similar fashion. The angles made by these timbers with the posts, are each braced by diagonal pieces framed or spiked to the horizontal timber and to the post, Fig. 22.

In the other method of exterior framing, called "balloon framing", the girts are omitted and the studs run from sill to plate. The usual way of forming the plate in this construction is to spike on the top of the studs a 2-×4-inch piece, and on top of this another 2-×4-inch piece, breaking joints and overlapping at the angles. Provision for supporting the intermediate floors is made by spiking a board 1×6 inches into notches cut in the inside of the studs so that the top of the board will be an inch above the bottom of the floor joists, Fig. 23. This board is called a ledger board. It is one of the weak points of balloon framing, not in the weight-carrying sense, but because of danger in case of fire, since, being more easily consumed, it does not prevent the spread of the fire as would a solid girt, and would, doubtless, let the floor fall. The floor joists should be notched over this ledger board, which should be kept back a little from the inside face of the studs to allow space for the mortar to clinch. Another weak point in balloon framing is the matter of braces. If used, the braces can be only short ones at the top and bottom, but they are usually omitted. A substitute sometimes

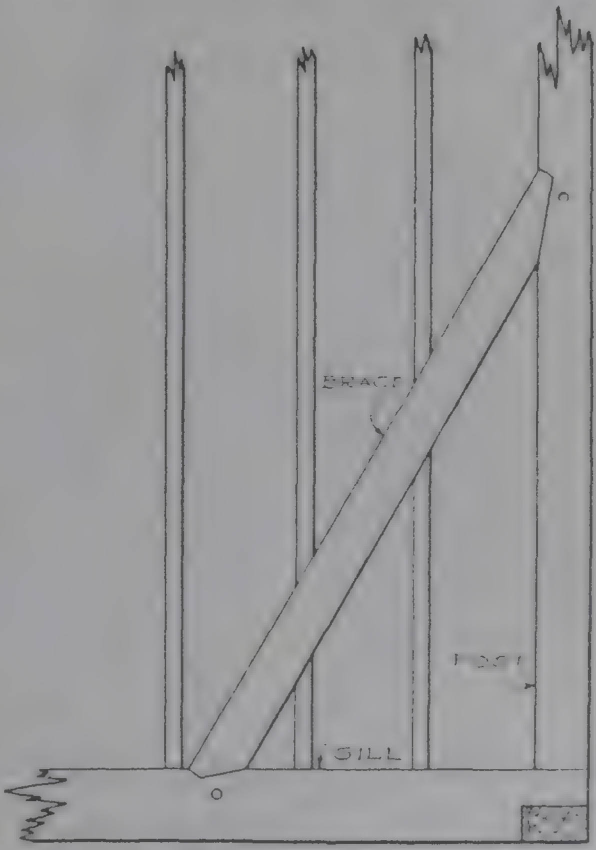


Fig. 22. Bracing for Exterior Frame

used, is a stout strip, usually 1 inch by 3 inches, cut diagonally into the outside of the studs and spiked to each. This makes a very strong brace but weakens the studding. The fact that the studs of a balloon frame run from top to bottom requires that the windows should be as nearly as possible over each other, so that one set of window studs will serve for both upper and lower windows.

Erection. The erection of the outside frame should be carefully watched to see that the door and window studs at least are tenoned head and foot, that all the braces are put in and properly framed, and that all the joints are snug and well pinned, the openings in the proper places, and the framing plumb and rigid. Nothing is more annoying than to find, after the outside frame is all up, that a window or door has been framed out of place, and although the builder may be obliged to rectify the mistake at his own expense, it can be done only by patching somewhere and the owner is very likely to feel that the error might have been prevented by the architect's more careful supervision.

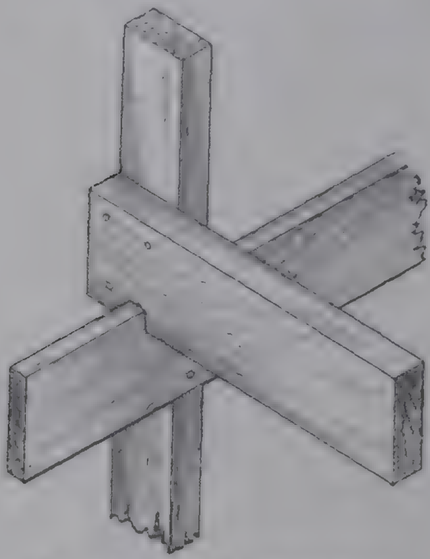


Fig. 23. Use of Ledger Board

Outside Boarding. As soon as the frame is set up, for our house a full frame which can be set up a story at a time (the attic joists only being carried on a ledger), the outside boarding is put on. Spruce or hemlock is used for this mainly, but it must be mill-planed to an even thickness so as to give a true surface for the outside covering of clapboards or shingles. We find that it is specified that the boarding shall be matched and laid diagonally upon the walls, and square-edged for the roof. The reason for not matching the roof is that the cracks in the square-edged boarding allow circulation of air under the roof shingles and preserve them much longer than if matched boarding were used.

Inside Bearing Partitions. When the first-story studding is up and the girts are on, the inside bearing partitions must be erected to give a support for the inner ends of the second-floor joists. It will not be necessary to set up all the studs of these partitions at first, but the partition caps should be run and studs put up at three-

or four-foot intervals, and as nearly as possible in their proper places, to avoid doing the work over again. As soon as this is done, the second-floor joists can be set and bridged and, with the outer walls carried up to the plate and another partition in the second story set, the attic joists may be put on and the building made ready for the roof.

At this juncture we are approached by the foreman who holds in his hand a smooth board upon which he has drawn a sketch of the attic joists and ledger board which he submits for our opinion. We examine his drawings and find that he has represented a ledger board 2×3 inches, notched into the studs one inch and up into the joists two inches, making the bottom of the ledger flush with the bottom of the ceiling furring, Fig. 24. This method he puts forth as having strength nearly equal to the 1-×6-inch board which is generally used, and the merit of not presenting so broad a surface behind the lathing at the top of the second story, which destroys in a measure the key of the plaster. We consider carefully this method in all its aspects and, admitting that it has these features to recommend it, we can praise the ingenuity of the device. If we were to run heavy cornices at the top of our second story we should be inclined to adopt the sketch, but as we shall run only a picture molding in the angle which would be helped rather than hurt by the presence of the wood behind the lathing at that point, we decide in favor of the usual way of putting in the 1-×6-inch ledger, but tell the foreman to notch the studs 1⅛ inches deep so that there will be a space between the laths and the ledger for a key to the plaster, Fig. 23.

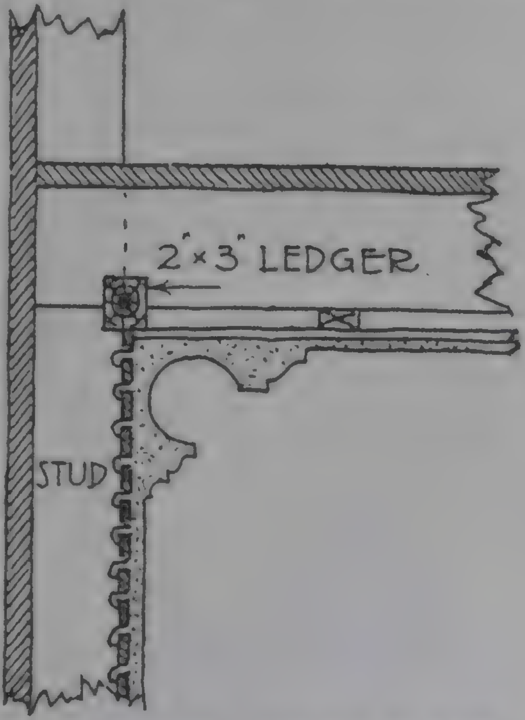


Fig. 24. Section Showing 2-×3-Inch Ledger Board Sometimes Used

Avoiding Unequal Shrinkage of Timber. An important matter in carrying the outside and inside supports from bottom to top is to see that the amount of shrinkable timber is, as nearly as possible, the same in both outside and inside walls. For this reason the common practice of setting the partition studs upon a horizontal piece laid on the under floor should be avoided, Fig. 25. For instance, in our case the amount of horizontal wood in the outer wall from the rigid underpinning to the attic joists will be as follows: the sill, 6 inches; the girt, 6 inches; and the upper part of the ledger board above its nailings, 2 inches—in all, 14 inches of shrinkable wood. If the inside partitions were set on a 2-inch sole resting on the under floor in each story, there would be in the inside wall, from the rigid piers in the cellar to the under side of the attic joists, the following amount: the girder, 10 inches; the two tiers of floor beams with under floors, 11 inches each; and two soles and two caps, 2 inches each—making, in all, 40 inches of wood, the shrinkage of which would amount to an inch and a half or more as against a probable half-inch on the outside walls. The result, when the house has become completely dry, would be that the inner end of the floor beams would be an inch or more lower than the outer end, enough to crack the plastering, and make doors bind in the cross-walls of the second and third stories. The remedy for this is to let the studs of the first story stand on the girders, and the studs of the second story stand on the cap of the first-story partition, and so on, so that the floor timbers do not form a part of the vertical frame, Fig. 26. This will give, in the case of our house, an amount of horizontal wood equal to the girders, at 10 inches, and the two caps at 2 inches each, making 14 inches in all, about equal to the horizontal timber in the outside frame.

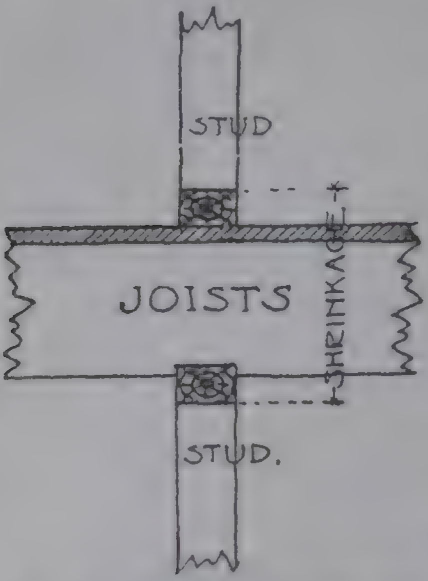


Fig. 25. Wrong Way of Setting Partition

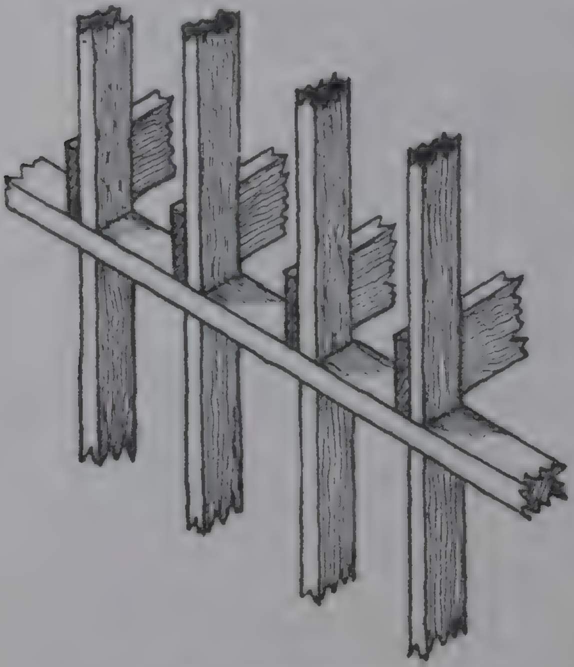


Fig. 26. Right Way of Setting Partition

Partitions running through two or more stories which do not carry floor beams should be built in the same way. Partitions which have no corresponding partitions under them will often occur and will be found in two conditions—those running parallel with the floor beams, and those running across the floor beams. In the former case it will be necessary to set two floor beams under the partition, spaced far enough apart to give a good nailing for the ends of the upper floor boards. In the latter case it will be necessary only to lay down upon the under floor a sole 2 inches thick by the width of the studs.

An important matter in relation to the leveling of the floors is to see that all measurements for sizing-down of the timbers are made from the top of the timber, so that the floor will be level on the top and any inequalities in the depth of the joists can be taken up in the furring. A half-inch will usually be enough to overcome the differences in the depth of the joists so that a series of 10-inch joists should be set with their tops 9½ inches above the girder or partition cap upon which they rest.

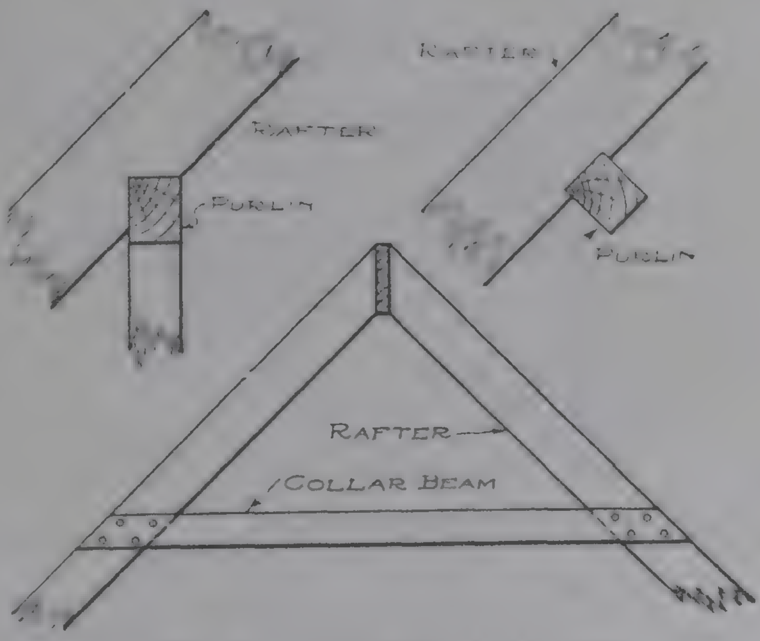


Fig. 27. Collar Beam and Purlins

Roofs. As soon as the attic floor is on, the roofs will be raised. In ordinary country houses the roof should be supported where possible by the interior partitions where these extend down to first-floor girders over basement piers, for in this case no complicated framing or truss work will be required. The usual form of roof consists of a series of rafters supported at the bottom by the plate of the house and at the top by the ridgepole. Intersecting roofs are supported by large timbers called valley rafters and these should always continue up to the ridge. If the rafters are over 18 feet long it will be necessary to support them near their center; this is done by partitions or by collar beams spiked across from rafter to rafter, Fig. 27. In large buildings they are supported by purlins resting on trusses or on posts. The spacing of the rafters varies from 16 inches to 2 or 3 feet, 20 inches being the most usual distance.

For any roof of less than a 30-foot span with the plate securely tied, no interior supports will be needed; for roofs of greater span, purlins should be used. The size of rafters not over 12 feet long should be 2×6 inches; from 12 to 18 feet, 2×7 inches and 2×8 inches; and over that length, 2×10 inches. On the whole it will be cheaper to reduce the length to 10 or 12 feet by means of purlins. An examination of the framing plans shows that our rafters are about 15 feet long and 2×7 inches in size, set about 20 inches on centers. The roof is a hip roof, that is, a roof which draws in from all sides; this is the strongest kind of roof, and we shall not, therefore, have to provide any special supports, and shall only have to see that the correct pitch is given according to plans, that the valleys are properly put in and are extended to the ridge or to the hips, and that the openings are of the right size and in the right positions. All portions of the roof must be well spiked together, the ridges perfectly straight and level and in the center, and the rafters all set exactly to a line.

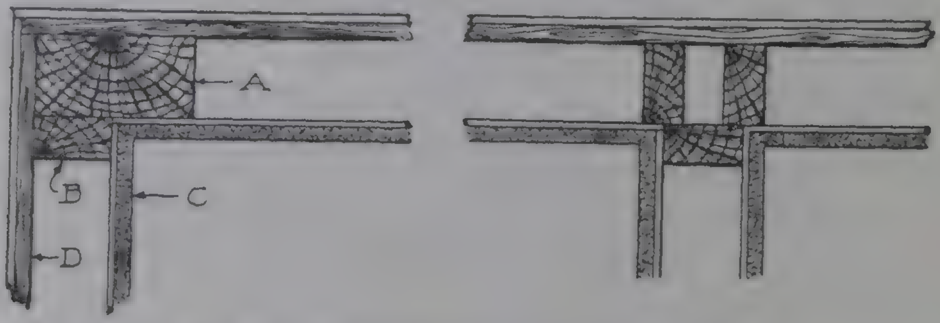


Fig. 28. Typical Construction for Corners

Partitions. With the covering-in of the building finished we may turn to the completion of the inside partitions, and these must be carefully followed to see that the studs are straight and plumb. Crooked studding may be straightened by cutting with a saw on the concave side and then wedging the cut apart. All studs which bear an extra weight, as those at the sides of large openings, should be examined to see that they have a sufficient support on the partition underneath, and do not come between the studs; in case they do, a block should be cut in under the partition cap, which should also be done where heavy timbers bear between studs. The corners must be examined to see that they are made solid for lathing, Fig. 28, and that provision is made for running pipes, etc. If any of the unsupported partitions running parallel with the joists are found to have a considerable span so that there is danger of too much sagging, the difficulty may be overcome, at a small cost, by trussing the partition, and if such a partition is used in any way to support floors or other partitions overhead, this should always be done. The studs at the sides of all openings are to be doubled, and all openings of more than 3 feet are to be trussed. The head of every opening should be doubled, with the lower piece 1 inch from the upper, so that if there is any sagging of the upper or weight-bearing piece, that will not affect the lower one to which the finish is nailed. All the partitions should be bridged, and all sliding-door pockets sheathed with end joints secured, to avoid every possibility of a board starting off. The lining of sliding-door pockets should be set upon heavy sheathing paper in such a way as to prevent the very annoying air drafts from the cellar.

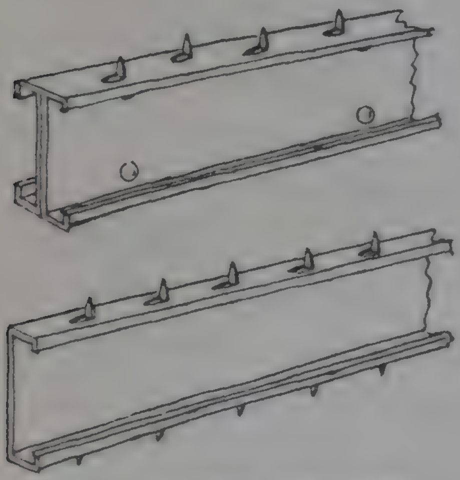


Fig. 29. Typical Sheet-Metal Joists and Beams

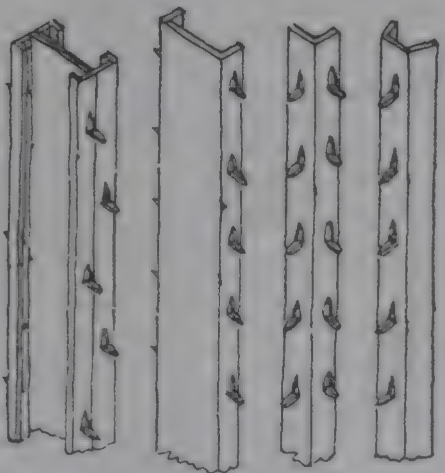


Fig. 30. Structural Steel Shapes with Prongs to Hold Metal Lath

Sheet-Metal Joists and Beams. Of a later development are the various patterns of framing-members constructed of sheet metal in shapes to perform the offices of girders, joists, studding, rafters, and other parts of the skeleton of a house. The beams of different makes consist in the main of a web member and flanges, either formed of a single sheet or riveted together in the form of I-beams, T-bars, and other shapes common to rolled steel, Fig. 29. These, being made of sheet steel, are somewhat limited as to strength compared with rolled-steel shapes, but they are well adapted to houses, ordinary public buildings, and mercantile buildings where moderate loads are to be carried. In many of their shapes the sheet steel of the flange or web is pierced and forced out in the form of prongs, Fig. 30, to which metal lathing may be secured by bending down the prongs, thus making a metal structure which is light and can be quickly erected up to the point of plastering.

MASON WORK

Chimneys. While these matters are being followed out by the carpenter, the mason must have started the chimneys, since the roof cannot be finished until the chimneys are topped out. The bricks which are furnished should be carefully inspected, and any that are soft, or easily broken by striking together, should be ordered off the grounds at once. The specifications call for good hard bricks. If the contractor is honest he will have ordered suitable bricks, and if they are rejected the loss will be the dealer's and not his.

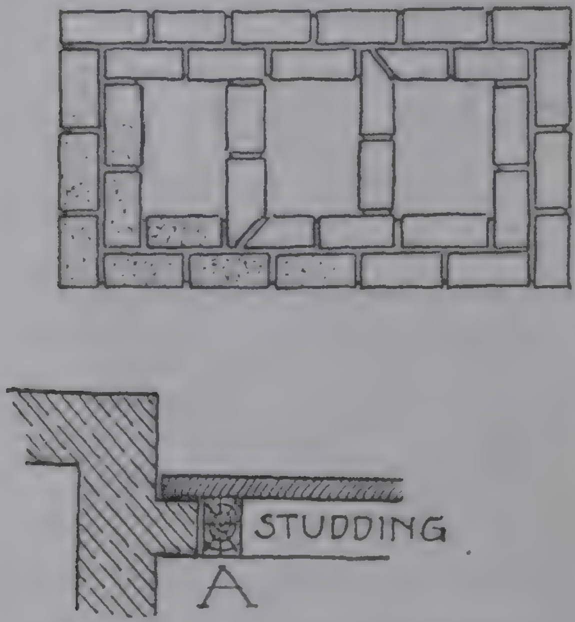


Fig. 31. Typical Chimney Construction

Inside of Chimney. Next in importance to the quality of the brick is the smoothness of the inside of the flues; this is best secured in unlined flues by cleaning off with the trowel the mortar which squeezes out of each joint as the bricks are laid. In some localities it is customary to plaster the inside of the flues with mortar, but there is always danger that after a while this plastering may become loose and block the flues. Chimney bricks should be laid solid in mortar, so that no cracks are left for the passage of sparks. The best plan, and what is specified in this case, is to use linings of vitrified clay. These not only give a smooth flue, but add strength to the chimney and permit the use of 4-inch walls everywhere. All ash doors, clean-outs, and thimbles should be of ample size, and set as the work goes up, and the withes bonded into the outer walls every 6 or 8 courses, Fig. 31. This will not be done unless close watch is kept by the superintendent.

Outside of Chimney. The rough fireplaces must be formed, with wrought-iron bars over each opening, and the outside of the chimney must be thoroughly plastered from cellar to roof. The topping out of the chimney is to be done with the hardest of the bricks laid in Portland cement mortar. If there is planned an enlargement of the chimney where it shows above the roof, this must be done below the roof boards so that there may not be the overhanging projection of the bricks just above the roof often found in old chimneys, for the settlement of the chimney, which is likely to occur, will leave the top supported by the overhang upon the roof and open a dangerous seam at this point. The settlement of chimneys is a matter which it is necessary to consider at all times as it is almost certain that there will be an unequal movement between the chimney and the house. If the chimney stands upon a ledge or other immovable foundation, the roof will invariably settle a little because of the natural shrinkage of the wood construction; but more often the chimney, by reason of its isolated foundation and the general shrinkage of the mortar joints, will settle more than the roof.

Method of Attachment to Roof. This danger of settlement, as well as the danger from fire, precludes direct attachment to any portion of the wooden construction. The chimneys are generally built, therefore, entirely free and are secured to the frame by strap-iron ties, which bend enough to adjust themselves to any settlement, either of the chimney or of the frame. In the case of outside chimneys, where protection from the weather becomes necessary, this natural movement between the chimney and the house must be recognized, and the chimney should be constructed with a projection of brick in line with the frame so that the boarding may run over and break the joint, *A*, Fig. 31. Where the top of a small chimney stands clear above the house for more than 10 or 12 feet, it should be stayed to the roof with iron rods. Two rods should be used, spread as far apart as possible at the point of junction with the roof, to give a measure of lateral support to the chimney. Lead for counter-flashing is to be furnished by the carpenter, for the mason to build into the joints of the chimney above the roof boarding, and care must be taken to see that the pieces are of good size and are carefully cemented into the brickwork at least 6 inches above the roof, and that they are ready to be turned down over the flashings which the carpenter will build in with the shingles. Behind the chimney, the flashings must be built in to a height that will allow proper room for building a saddle, to turn the water to either side.

Caps. When the stone caps for the tops of the chimneys arrive, they should be carefully measured on the ground, to be sure that they are of the correct size and that the holes for the flues are large enough, of the right shape, and in the proper position. For a large chimney with thick walls, it may be necessary to make the stone cap in pieces, and when this is done, the stones must be carefully tied together with galvanized iron or composition clamps. The excessive projection of bricks to form the chimney top is a thing to be avoided, $\frac{1}{2}$ to $\frac{3}{4}$ inch to each course being all that should ever be allowed. In determining the projection of the top, it must always be remembered that the projection at the corners will appear greater than the natural projection of the courses, and there will be more danger of finding the completed top too large than too small. Projections from the shaft of the chimney must be protected on top by a weathering of Portland cement, and where an outside chimney is reduced in size the weatherings should be of stone.

Back Plaster. With the topping out of the chimneys, the mason, who in suburban work is very likely to be the plasterer as well, should turn his attention to the back plastering, if there is to be any. The back plastering is done in several ways, a common method being to nail strips to the sides of the studs and to lath upon these, the whole surface between the studs being covered with a rough coat of plaster, Fig. 32. Care must be taken to bring the mortar well out on the studs, and even then when the studs shrink there may be a continuous crack along the side of the stud from top to bottom. This, if it happens, will defeat the whole purpose of the back plastering and it is so likely to occur that other means than those just described are often taken to obtain a better result. One of the best methods is to lath the house on the studding and to put on a rough coat of plaster, then to fur off with $\frac{7}{8}$-inch strips and lath and plaster again for the finished work, Fig. 32.

Fire Stops. In connection with the back plastering, may be done the fire-stopping of plaster or bricks. The principal point is to build with brick on the underpinning behind the sill up to the underside of floor, not only to prevent the spread of fire, but also to prevent rats from going from the cellar up into the walls and so all over the house. On the top of girders the same thing should be done, and if the girders support partitions, the brick work should be carried up between the studs for a distance of 3 courses or more above the floor, Fig. 33. By repeating this operation upon each partition cap and upon the girts of the outside frame, the whole house will be cut up into compartments and the circulation of fire and vermin materially checked. In the case of a balloon frame where there are no girts, it is customary to run the floor boards out between the studs and to build up on these with the bricks. A further precaution, and a valuable one, is to lay a few courses of bricks upon

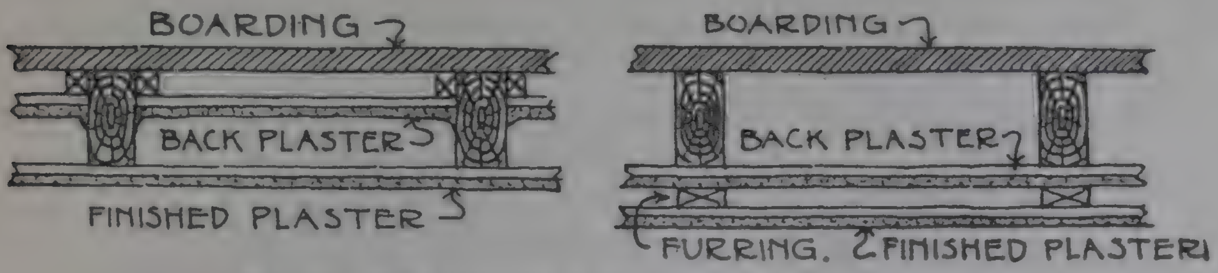


Fig. 32. Two Methods of Finishing Off Back Plastering

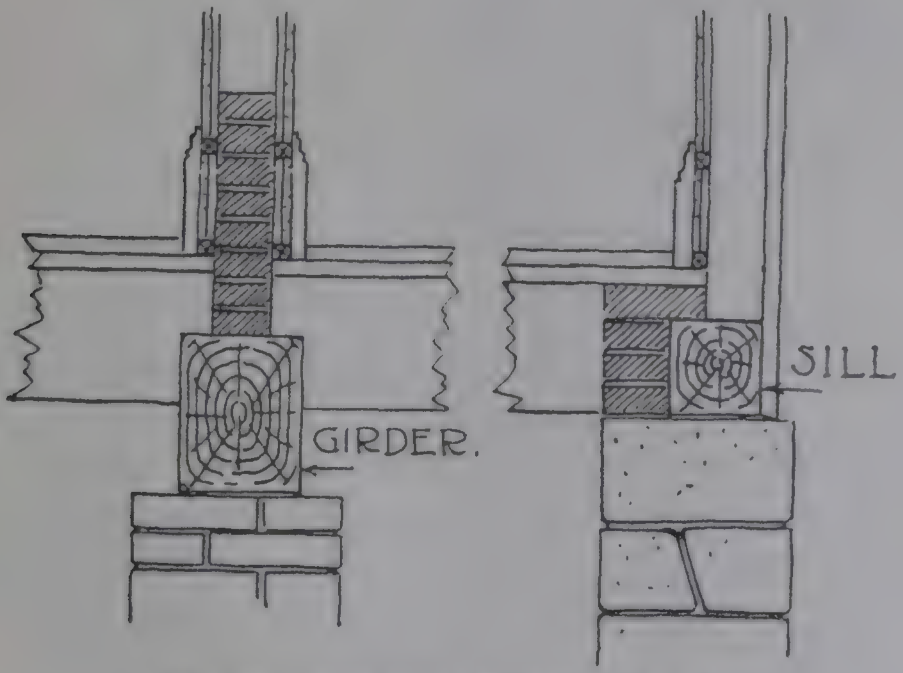


Fig. 33. Brick Filling Used as Fire Stops

the bridging of partitions; this will cause any fire which may have started below to break out in the lower room, where it will be discovered before it is likely to reach the story above. The spaces between stair stringers and around chimneys should also be protected by fire stops of brick or plaster.

OTHER OPERATIONS CARRIED ON WITH FRAMING

Framing Details. As soon as the roof is on and boarded, the gutters will be put up and the roof shingling begun. The position of the gutters must be carefully noted to be sure that the edge is on a line with the roof boarding, for otherwise the gable finish will not work out correctly. The position of the conductors should be determined, and the gutters set with a slight fall toward them, and holes for the lead goosenecks should be bored, in order that no water shall stand in the gutters. With the completion of the gutters the shingling or slating of the roof can be commenced, and before the roof is completed the furring of the inside will be discussed.

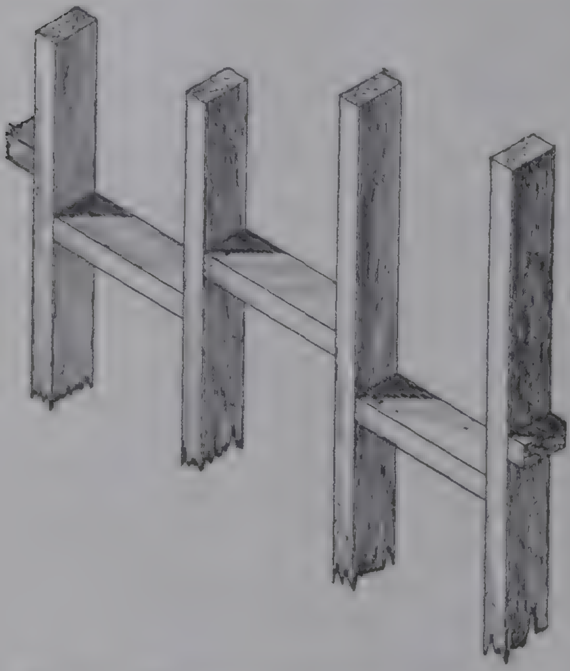


Fig. 34. Horizontal Bridging of Partitions

Beyond the setting of minor partitions which were not needed for the support of floor beams, the principal work of interior framing will be the furring of chimney breasts, and the forming of beams and arches. The position and size of every door must be carefully verified, especial care being taken to allow the proper width for door casings where doors come close to the corner of any room. When the studs of all interior partitions are set up they must be bridged. This is often done by cutting in horizontal pieces between the studs, Fig. 34; but a better way is to cut in the pieces diagonally, Fig. 35. The chimneys must be enclosed by vertical studs, usually 2-×3-inch or 2-×4-inch, set flatways and at least an inch away from the brick, Fig. 36, with an ample, well trussed opening left for fireplaces. All door openings must also have a truss over them, and any partitions which have no adequate support beneath should be trussed, if the arrangement of doors will by any means allow it.

The ceilings will be cross-furred with $\frac{7}{8}$-×3-inch strips, commonly called "strapping". These strips should be carefully leveled and straightened, since upon their evenness depends the smoothness of the ceiling; above all it is necessary that the strips be well nailed to every joist. Grounds are next set and angle beads for lathing, but before any laths can be laid there are a number of things to be considered.

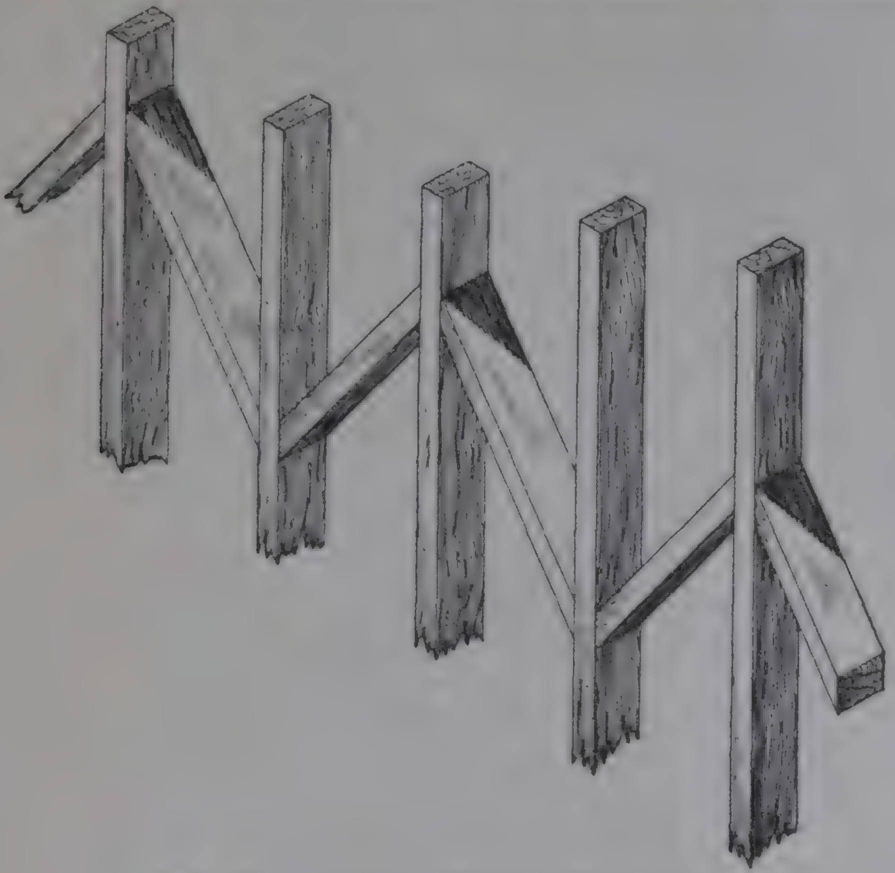


Fig. 35. Diagonal Bridging of Partitions

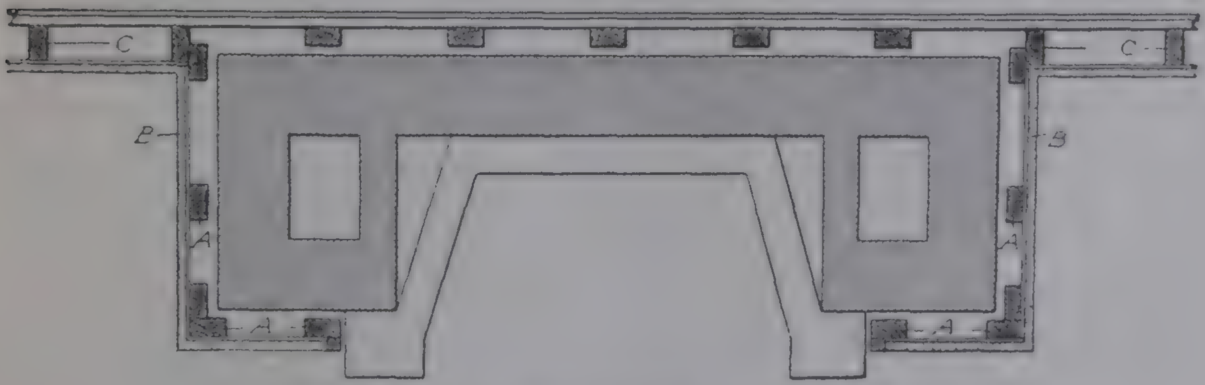


Fig. 36. Typical Section Showing Chimney Furring

Furnace Pipes. In the first place, all hot-air pipes which are not to be exposed must be put in position. If a hot-air system has been selected, the position of the pipes and registers will have been marked on the plans, but frequently in the execution changes suggest themselves or are required by unforeseen circumstances, so that the superintendent should make a personal study of the piping at the building. Where it is possible to arrange it, the pipes should be run through closets, exposed to view; but this cannot always be done, and it often happens that the chimney breasts and sometimes the partitions must contain hot-air pipes. The best and safest way to do in that case is to make the pipes double with at least a half-inch air space between the outer and inner pipes. This is expensive and is not generally done; instead, the woodwork which comes close to the pipe is lined with bright tin, and heavy wire lathing rather than wood laths is used in front of the pipes. Where the pipes are carried through the partition or woodwork, a sleeve of bright tin a half-inch larger than the pipes should be provided as a safeguard against the overheating of the pipes.

Ventilation and Gas Pipes. Although it is customary nowadays to run the plumbing pipes outside of the plaster, there are some ventilation pipes that need to be provided for at this time. All of the enclosed gas-piping must be done before lathing. From the fact that the gas-piping must be carried in almost every case to the center of the ceilings, there is need of careful watching lest the cutting by careless workmen weakens the joists. The specifications distinctly state that no floor beams shall be cut into, more than 2 feet away from their bearing, but as this means that all outlets in the centers of ceilings must be reached by branch pipes between the joists, and as this entails more piping and labor for the gas-fitter, there is a great temptation to disregard instructions and to cut the joists for a straight run from center to center of rooms. Only constant watching will prevent this being done. Care must be taken that the pipes are run with a continuous drop toward the meter, to allow the liquid, which is always condensed from the gas, to run off; and, for the same reason, wall outlets must be piped up from below, and ceiling drops should be taken out of the *side* or *top* of the pipes. The position of all outlets must be verified, especially those which are centered in the rooms, and they must be set at right angles to walls and ceilings. This can be proved by screwing on each outlet, as soon as set, a piece of pipe a foot or more in length and testing with a steel square. No "gas-fitters'" or other cement should be allowed, but all pipes should be put together with red lead. The outlets to receive fixtures should be strongly secured to prevent springing or movement in the plastered work.

Testing. When the piping is all in place, the outlets are to be capped and the whole system tested for leaks, and then accepted by the local gas company. The test consists, briefly, in attaching to one of the outlets a mercury gage, and then filling the pipes with air under pressure till the mercury in the gage stands at the height required to insure tightness, which is usually 6 to 12 inches. The apparatus is then left to stand for 10 or 15 minutes, and if the mercury at the end of the time holds the same level it is safe to say that the pipes are tight. Leaks may usually be discovered by the sound of the escaping air, but often ether is put into a cup attached to the pump and forced in with the air, so that leaks, especially in concealed parts of the piping, may be detected by the odor. Suspicion of a leak in pipe or fittings may be verified by brushing strong soap water over the place; if there is a leak, a bubble will be blown by the escaping air. Small pinholes in the pipe or couplings

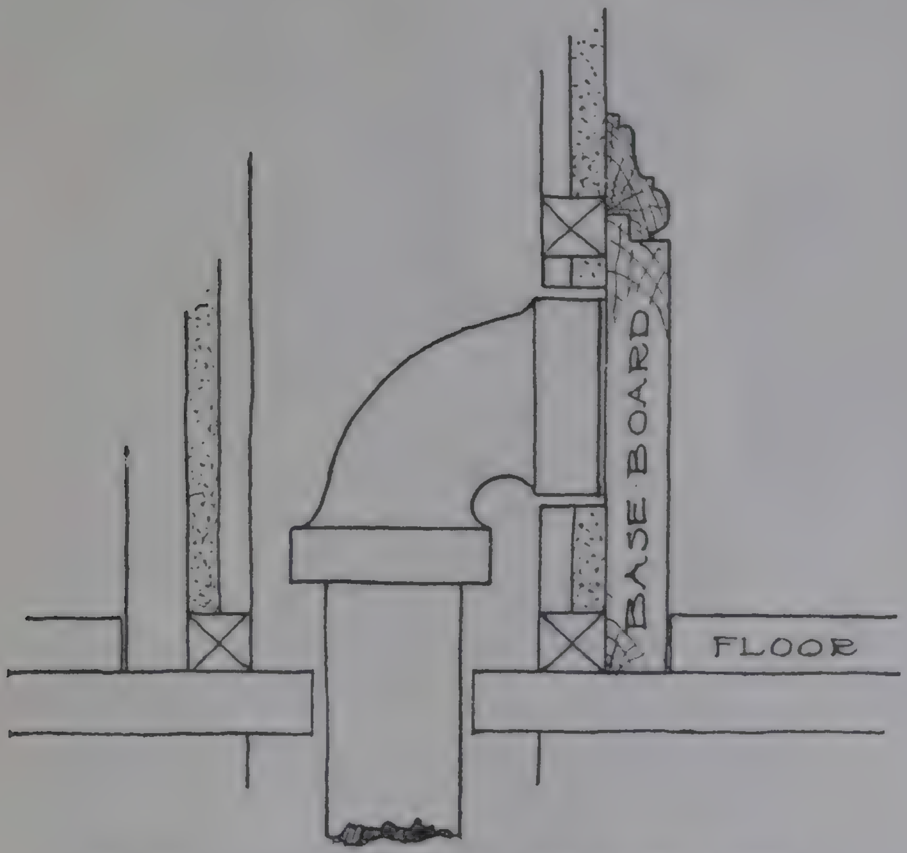


Fig. 37. Connection of Outlet Pipe with Main Pipe of Vacuum-Cleaning System

may be tamped and if thus rendered tight will remain so, but pipes showing a split or large hole must be replaced.

Vacuum-Cleaning Pipes. At this time also pipes should be run for a vacuum cleaner if the system is to be installed, and in any case it is a good plan to put in a line of pipe from cellar to attic as the expense is slight and pipes run at this time can be concealed.

While portable cleaners are very efficient and easily handled, they are not so convenient as a basement machine which requires only hose connections in each story. Care should be taken that outlets are centrally located and that the outlet pipe joins the main pipe by an easy sweep, Fig. 37, and not with an elbow or T-connection. As the piping varies in detail for different machines, it is well to consider some particular make and pipe according to the manufacturer's recommendations. The methods of starting and controlling the machine from distant points should be considered, and the proper connections, electric or otherwise, installed.

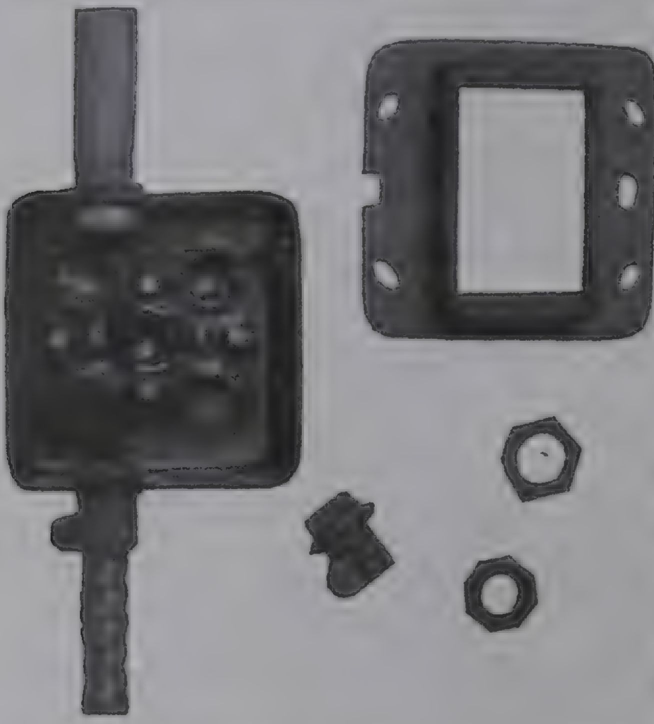


Fig. 38. Outlet Box with Connecting Conduit

Electric Wiring. All country houses even in remote places should be provided with conduits for electric lighting. The outlet boxes, Fig. 38, should be provided in ceilings, walls, and baseboards, and should be so set that they can be readily located if the wiring is completed at a later date. It is the duty of the superintendent to see that this work is reported promptly to the local inspector and passed by him and a certificate of inspection obtained. He should also see that the conduit is so arranged as not to interfere with the plumbing, stairways, windows, and doors. Where armored cable is used, he should see that the arrangement is made to avoid driving nails through the cable.

Improper installation of the wiring delays the work and sometimes makes it necessary to remove lath and plaster, alter the positions of doorways, and causes much needless expense and confusion. The metal boxes for light and switch outlets should be set square and firmly secured. The superintendent should also see that the wiring is tested for proper distribution and insulation when the wires are drawn in.

At a cost between knob-and-tube wiring and conduit work, *duplex wiring* may be installed, in which a flexible metallic cable containing the wires in pairs and heavily insulated is used. These cables, of various makes and usually spiral in appearance, Fig. 39, unite the flexibility of the open wiring and the protective quality of the conduit, are easily handled, and assure a good quality of wire, being manufactured under the approval of the Board of Fire Underwriters. They are to be recommended for good house-wiring.

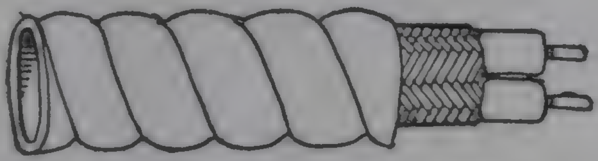


Fig. 39. Typical Armored Cable for Duplex Wiring

Metal boxes can be used to advantage at the surface, for either light outlets or switch outlets, and in many localities are required. As the position of these boxes determines absolutely the position of the finished switches and fixtures, it is important to see that they are set plumb and square with the wall and the proper distance away from rough door or window openings to clear any proposed finish. All wiring should be tested when installed and again at completion of the building, to insure against any mechanical injury.

Telephone Wires. Conduit should also be run for the telephone wires. The absence of proper provision for these wires makes it necessary to cut holes through plastering and to run the wires over doors and staple them to casings. The cost of providing conduit is small and prevents marring the decorations in the installation of the telephone service. Special attention should be given to the general layout of the conduit to see that it is not in contact with heating pipes, plumbing pipes, or gas pipes, except where the latter are joined in an outlet box.

OUTSIDE FINISH

Before the building is ready for the plasterer, the outside and the roof must be made tight. We have seen that the gutters are set and primed or oiled to protect them against water; and above the gutter, and rebated or tongued into the back, is set the "shingle fascia", a vertical board varying in width according to size of gutter and pitch of roof. This fascia is usually beveled off on top to receive the butts of the first course of shingles, Fig. 40.

Shingles. The shingling of the roof begins upon the fascia with a double course projecting a little, and from the butts of these shingles are measured off the courses of the roof. Unless the roof is very steep the courses should not exceed 4½ inches for the length of 16 inches, into which cedar and redwood shingles are usually sawed. Cypress shingles are found 18 or 20 inches long and are the most durable of all shingles, but redwood and cedar, especially cedar, are more commonly used. Regarding durability, cypress shingles have been known to last more than a hundred years, redwood shingles from twenty-five to fifty years, and cedar shingles from twelve to twenty years.

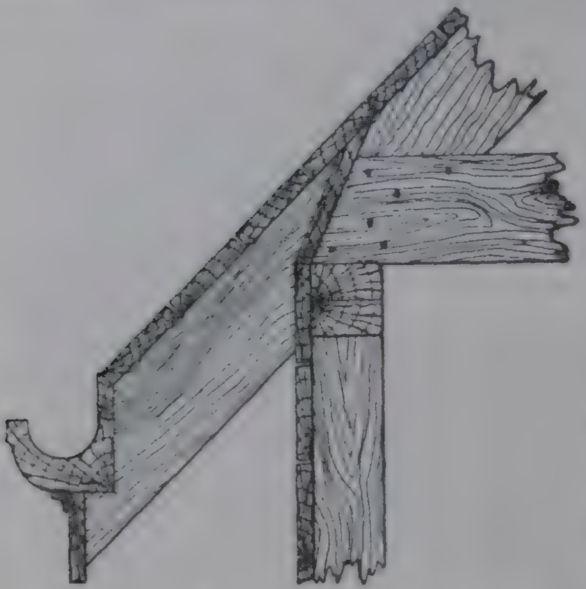


Fig. 40. Typical Gutter Construction

Paper. The question as to whether paper shall be put under shingles or not is open to argument. If the shingles are laid without being dipped in paint or with the butts only dipped, the paper will cause sweating, and, preventing any circulation of air under the shingles, will cause them to decay much sooner than if paper were not used; but, on the other hand, if the attic is plastered, there is, without paper, danger of damage from leaks and from fine snow sifting under the shingles. In the present case the attic is to be unfinished and we will use no paper on the roofs.

Ridge and Hips. The ridge of a shingled roof is usually finished by means of saddle boards nailed over the tops of the last courses, Fig. 41, but sometimes an ornamental cresting is used. Hips are best finished by what is called "saddle-board shingling", in which a course of shingles is put over the roof shingles at right angles with the hip. There is little danger of roofs leaking at the ridges and hips, but the hip shingles unless well nailed are likely to be blown off. The plane surface of the roof is not liable to leak, if reasonable care is taken, but dormers, chimneys, and valleys are sources of great danger.

Flashings. The flashing against chimneys and the vertical sides of dormers is done by means of pieces of tin or zinc about 7 inches square, bent in the middle so that one-half will lie in the course of shingles and one-half turn up against the vertical wall, to be covered by the shingles of the wall or by the counter-flashing of the chimney. In the eastern States zinc is generally used for flashings, but in the West tin is the common material.

In the forming of valleys, one of two methods is followed, that of an "open" or a "close" valley. In the former case the shingles are kept apart 6 or 8 inches, and the valley is made of zinc or tin, often in long strips locked and soldered at the joints and running under the shingles from 4 to 6 inches. The defect in this method of a continuous piece of metal is that there is no chance for the metal to expand and contract in its length, without danger of straining the joints and even of starting the shingles or slates which are laid over it. For this reason the use of separate pieces of metal of the length of shingles or slates and shingled in with each course is to be preferred. These are bent, lapped in the same way as the shingles, without soldering, and are free to expand and contract without damage. In the case of the close valley, the shingles are laid very near together at the angle, and narrower pieces of zinc or tin are shingled into each course.

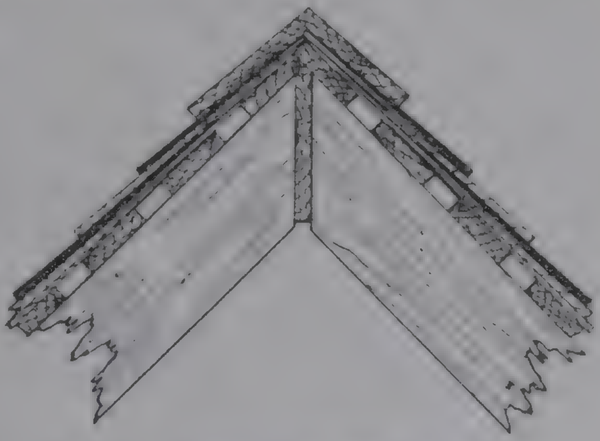


Fig. 41. Section Showing Ridge Finish

The flashing of roofs is a matter which needs a great deal of attention on the part of the superintendent, who should look especially to see that the metal used is wide enough. Counter-flashings are often omitted unless particularly mentioned. Where used, they should always be built into the brickwork if possible; if not built in, they must be carefully wedged into joints which have been raked out and pointed with cement. Every part of the flashing of a roof should be examined by the superintendent; it must never be left to the care of the builder or the workmen.

Nails. The use of galvanized nails for shingling has become general. They should be of the variety known as "cut nails" which contain a greater body of metal than wire nails and do not rust out so soon.

Slating and Tiling. With slating or tiling greater care is necessary than with shingles. Neither slates nor tiles will lie as close to the roof, or to each other, as shingles, and for this reason the boarding should always be matched, and, since the circulation of air is no object with slates, tarred paper should always be used. The lap of the slates should vary with their length, at least 3 inches for headcover being allowed; that is, each slate must lap 3 inches below the head of the second slate below it. Tiles are constructed with a variety of joints and laps designed to meet the needs of the different forms of the tile. Both slates and tiles should be put on with galvanized nails, which must not be driven too hard for fear of cracking, and yet must be driven hard enough to prevent loosening or rattling. If the cost is not too great, copper should be used for all gutters and flashings. It is a good practice to lay the first three or four courses of a slate roof above the gutter in elastic cement, and also all hips and ridges.

Fire-Resisting Roofings. The increasing demand, especially in metropolitan districts, for a fire-resisting covering for roofs has resulted in the manufacture of "shingles" other than of wood. Asbestos, tin, steel, and various types of paper coated with slag, asphalt, and other fire-resisting substances have been put upon the market. All of these aim to preserve appearance as well as to secure safety, and it is a mere matter of selection, if some other material than wood must be used. The main objection to most of these substitutes is that those of moderate cost are likely to have a rather thin appearance, or else give a metallic look which although well in itself does not generally please the taste as does the old wooden shingle.

WALLS

Window Frames. After the completion of the roof comes the preparation of the side walls for the finishing, and the first thing to be done is to set the window frames. In wooden houses the stud will usually make one side of the weight box, and the frame will consist only of the pulley stile and casing. Sometimes the boarding is kept back from the edge of the studding, and the casing is set upon the studding with a piece of finish or a "backband" put over the joint with tarred paper or, better still, strips of zinc, to keep out the water, Fig. 42. If the frame is set against the usual 4-inch studding, the outer casing will form one side of the groove in which the sash slides, but in the other case there is room to put a strip ⅝ inch or ¾ inch wide inside the casing, in which the sashes may slide, and to leave a space for mosquito guards, Fig. 43. The top of the frame must be flashed with lead, and the bottom of the sill grooved to receive the top of the shingles or clapboarding, which are put on as soon as the frames are placed. Pockets of canvas, in which the window sill is set, are advisable in exposed situations.

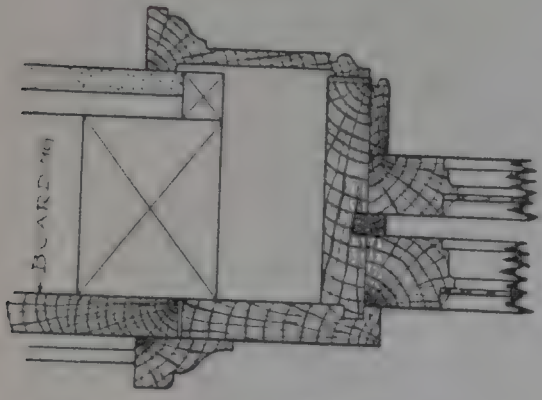


Fig. 42. Section of Window Frame Flush with Boarding

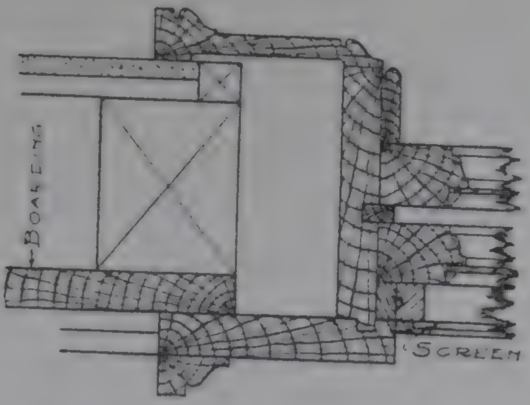


Fig. 43. Section of Window Frame Outside of Boarding

Coal Chute. To avoid the marring and soiling of the cellar window frame by the putting in of coal and wood, a metal chute of stock pattern may be installed, which, if desired, may take the place of a window. It consists of a metal frame with a hinged cover which turns up entirely out of the way, disclosing a metal hopper that can be pulled forward and used as a chute for the coal, Fig. 44. If set to take the place of a window, the cover is glazed, otherwise it is better if made solid, unless the chute is in a conspicuous location.

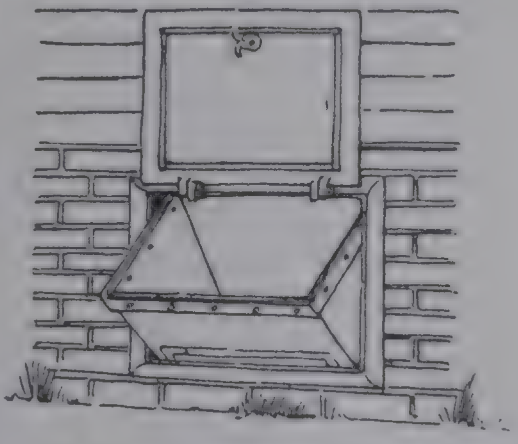


Fig. 44. Typical Coal Chute for Basement

Porch and Piazza. Before the clapboarding or shingling of the walls can be completed, the porch and piazza finish must be put up. The floors should be framed with the joists running parallel with the house walls so that the boards will be perpendicular to the walls, and the floor boards must also slope away from the house at about the rate of 2 inches in 12 feet. The tops of the piazza joists should be set about 6 inches below the main house, and it is a good plan to bevel off the tops and leave only a narrow edge for nailing, so that the water, which will run between the joints if the floor is open, will find little surface upon which to settle, Fig. 45. Sometimes the joists and girders are covered with tarred paper. The roof of the piazza, which is covered with tin, will need especial attention to see that it is given a proper pitch and that the tin is turned up against the boarding of the house wall at least 6 inches, where it will be clapboarded over. The quality of the tin should be examined, and care taken to have it painted on the underside before being laid and to have the joints well locked and soldered. Blocks must be set on the tin roof and flashed and soldered, to which the balcony posts can be secured; and where the finish of porch or piazza ends against the house, great pains must be taken to have the connection thoroughly flashed with lead.

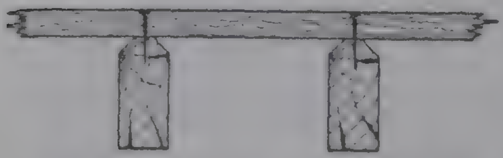


Fig. 45. Proper Construction for Piazza Joists

Clapboarding and Siding. Clapboarding is done in sections, from staging lowered successively as the work progresses. Each section is built upward from the staging, its top board being slipped under the lowest board of the preceding section, which has been left unnailed along the bottom for that purpose. The term "clapboard" in New England corresponds to "siding" as used elsewhere. Clapboards are all quarter-sawed, being cut from the log by a circular saw which cuts always toward the center; they are made 4 feet long, 6 inches wide, and $\frac{1}{2}$ inch thick at the butt. Siding is of similar section but a little thicker, and is commonly sawed in the same way as boards, in lengths of 12 to 16 feet. Either clapboards or siding make a good wall covering; the best should always be quarter-sawed and laid over a good quality of sheathing paper, which is generally put on in horizontal layers, each layer being lapped about 2 inches and breaking joints with the paper and flashings already laid.

There are many good brands of paper on the market, with very little to choose between them, the principal qualities required being toughness and soundness. A kind of siding called "novelty siding" is often used for cheap summer houses. This is nailed directly to the studding without any rough boarding, but the omission of the rough boarding, it should be noted, is always done at a great loss in strength and warmth.

Wall Shingles. If the walls were to be shingled, the same care would have to be taken as in shingling the roof, except that the shingles on the walls may be exposed 5 or 6 inches and they may be of a quality called "clears", in which the exposed lower third is free from imperfections. Shingling undoubtedly makes a warmer coating than clapboards or siding, as there are always three thicknesses of shingles to one of clapboards; but the choice between shingles and clapboards is generally determined by the character of the building and the effect desired.

LATHING AND PLASTERING

By the time that the clapboarding has been finished the inside of the house must be given over to a new set of mechanics—the lathers. The trade of lathing, although a wood-working trade, is in most localities distinct from the trade of the carpenter, and the lathers will come to the building to put on laths and for nothing else. For this reason it is well for the superintendent to see personally that all of the furring has been completed and completed properly. Walls, ceilings, and soffits should be carefully examined to be sure that their surfaces are true, level, and plumb; chimney breasts and projections of all kinds tried with a square to be certain that all angles are true; corners examined to see that nailings are provided where the laths are to make an angle; and grounds and corner beads set wherever necessary for nailings or for a finish.

Corner Beads. The use of corner beads is a matter of custom, being general in New England and less frequent in the West. In recent years the use of metal corner beads has become common, and they are to be preferred where a sharp corner is desired. Either wood or metal corner beads should be used, as they mean a saving of time to the plasterer, and, being set and rigidly secured by the carpenter while furring the house, insure a plumb and square corner. The superintendent should see that all beads are in one length, and that they are set plumb and square. Especial attention must be paid to arches, since the perfect shape of the arch is determined by the accuracy of the beads, and it will be difficult to remedy any defects after the plaster has been applied.

Lathing. When the superintendent is satisfied that the rough work has been put in place correctly, the lathers are set to work. It is well to visit the building before much of the lathing has been done, to see that the laths are given the requisite number of nailings and are spaced properly. Three-eighths of an inch apart is the right width, but there is generally a tendency to put them too near together, in which case the mortar will not press through and form a sufficient key. If the laths are spaced too far apart, the wet mortar will not sustain its own weight. The matter of breaking joints is also of importance, the usual way being to break joints every sixth course, *A*, Fig. 46, but a better ceiling is obtained by breaking joints at every lath. Over door and window openings the laths must extend at least to the next stud beyond, to prevent cracking, *B*, Fig. 46. The direction of the laths must never be changed, and this is a point which will need to be remembered, as there is a great temptation to fill small spaces which occur with laths running diagonally and even at right angles to the other lathing, *C*, Fig. 46. This must not be allowed, as cracks are sure to appear where the change in direction occurs. The laths themselves should be well seasoned and free from large or black knots, bark, or stains. Bark, which is usually found on the edges, is a serious defect, and any laths showing this should be

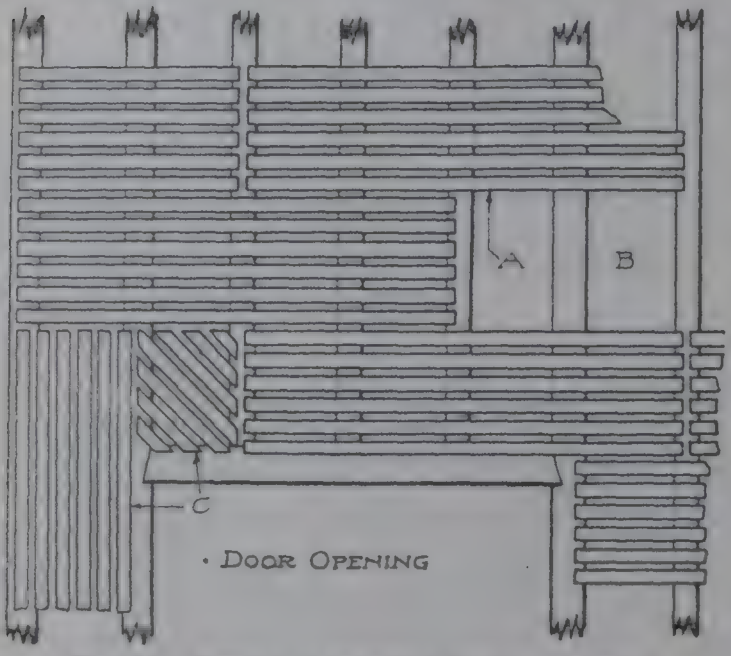


Fig. 46. Portion of Partition Showing Method of Lathing

pulled off and fresh laths placed, as the bark will invariably cause a stain in the plaster.

Metal Lathing. The use of metal laths is continually increasing and should be encouraged even for wooden houses. This form of lathing holds the plaster more firmly and is not so likely to crack or sag, and it is almost impossible to detach it even if soaked by water. Added to this are the fire-resisting qualities, which render its use advisable for the soffits of stairs in public buildings, under galleries, and over all hot-air pipes enclosed in partitions. Metal laths should always be used where wooden walls connect with brick walls or chimneys; and wherever a solid timber of any size is to be plastered over, a strip of metal lathing covering the timber and lapping well on to the adjoining wooden laths will tend to prevent cracks which would occur if wooden laths only were used. Lathing for exterior plastering should be galvanized or painted, and furred at least $\frac{7}{8}$ inch from the boarding.

Plaster. With the completion of the lathing the house will be ready for the plasterer. Already the mortar will have been mixed, and, piled in large stacks, should have been standing for a week or more. The sand and lime having passed the same scrutiny and tests which we employed when making the mortar for the mason work, the only thing necessary is to see that the mortar is well mixed and tempered and that hair of the proper amount and quality is added at the proper time.

Mixing. For the best results, the lime should be thoroughly slaked at least twenty-four hours before adding the hair, which must be thoroughly beaten up and mixed with the lime paste, and the necessary amount of sand added. This mixture should then be stacked outside of the building as long as possible before being used; for our building, at least ten days. When ready for applying, small quantities of this mixture are wet with water to the proper consistency—*tempering*, this is called. Unless particular care is taken, the sand and hair will be added as soon as the lime is slaked as it is much more convenient to do; but this should not be allowed, as the lime does not always get wholly slaked and the steam and heat of the slaking lime will burn the hair and destroy its strength. Another practice which should be avoided, is that of mixing the mortar in the basement of the building, for the steam and moisture will penetrate to all parts of the building at a time when the immediate application of the plaster gives no opportunity for drying off.

With regard to the proportions, about 1½ bushels of hair and 3 barrels of sand to 1 cask of lime is a good ratio, but the amount of sand will in ordinary cases be determined by the judgment of the mixer, who should be a competent and experienced man.

Applying. When the mortar is ready for putting on the laths, we must see that the first or scratch coat is well troweled to push it through the spaces between the laths so as to form a good key. In ordinary two-coat work, this first coat is put on thick enough to come within ⅛ inch or less of the face of the grounds and beads, as the finish or skim coat is merely a thin veneer of lime putty and fine white sand, troweled and brushed to a hard surface. In three-coat work, the first coat is put on about ¼ inch thick, and when somewhat hard it is scratched with diagonal lines nearly through to the laths. As soon as this coat is dry, the second coat is applied and brought to a plane with all angles and corners true and plumb. On large surfaces or in important work this is best done by running screeds, which are strips of mortar 6 to 8 inches wide and 3 or 4 feet apart, carefully laid and leveled and plumbed, with corners and angles made true and brought to the line of the second coat, which is filled in between these upon the scratch coat and brought to a line by running straightedges from screed to screed. Upon this second coat is applied the third or finishing coat, usually either the skim coat used in two-coat work, or a white coat made by mixing plaster of paris and marble dust with the lime putty. If a rougher finish is desired, as for frescoing, a coarse sand in greater quantities may be mixed with the lime putty and floated with a pine or cork-faced float. By consulting the specifications we find that this finish is called for in two-coat work to be left "medium rough".

Screens for Protecting Plaster. Before plastering is begun, the windows must be closed in with screens of cotton cloth tacked upon wooden frames made to fit the window openings. These are not only to protect the plastering from freezing, which completely ruins ordinary lime mortar, but also to prevent the unequal drying of the finished walls, which will occur near the windows in breezy weather.

Exterior Plastering. Cement plaster as a covering for exterior walls—generally called stucco—is being used to an increasing extent in the United States. It is put on over the boarding by furring off with $\frac{7}{8}$-inch wood strips or iron rods, or it may be applied directly to the studding; wire or other metal lathing should be used in either case, and it is best to have it galvanized or painted. The plastering should be three-coat work, with one-third of Portland cement for all three coats, the last containing the coarse sand or gravel if a rough finish is desired. If metal lathing is not easily procured, a good result is obtained by lathing upon the boarding diagonally with $1\frac{1}{2}$-inch spaces and repeating the lathing diagonally in the opposite direction, all well nailed and secure. Upon this we may plaster as upon the metal lathing.

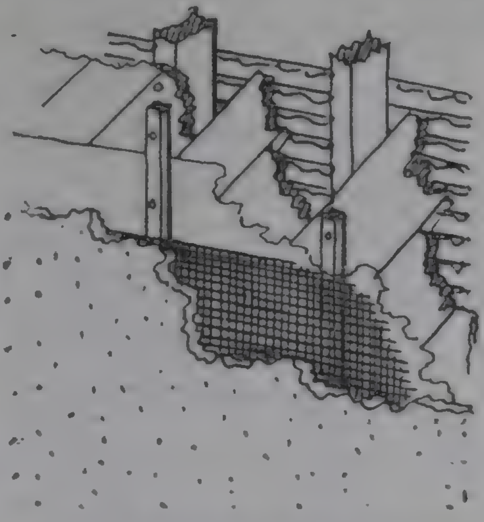


Fig. 47. Furring for Metal Lathing on House Boarding

The framing studs should be set 12 inches on centers and, so far as possible, should run from sill to plate with no horizontal timbers to cause shrinkage. This frame should be rigidly braced to avoid cracking the finish. If house boarding is used it should be in narrow widths, from 6 inches to 8 inches, matched and laid diagonally, with two nails to each stud. Waterproof paper should be laid over the boarding, well lapped and tacked, and upon this paper vertical furring strips of wood or metal are placed to receive the metal lathing, Fig. 47. These strips should be placed not more than 12 inches apart and preferably upon the direct line of the studs of the frame. Upon these furring strips the metal lathing is secured in horizontal strips, doubled at corners or reinforced by a strip of metal lath, bent and applied over the lathing. If house boarding is not to be used, the lathing may be stapled directly to the studding, Fig. 48, or, better, the metal may be fastened over quarter-inch iron rods or crimped metal stapled to the studding.

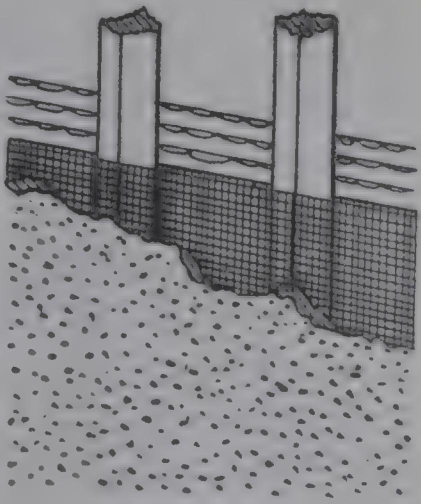


Fig. 48. Furring for Metal Lathing on Studding

Upon the lathing three coats of strong Portland cement mortar are applied, finished with a troweled surface if a smooth effect is desired; or the finish may be of any degree of roughness, from a sand-floated surface to the extreme of roughness produced by throwing a strong mixture of cement and sand or wet pebbles against the finishing coat. It is also possible to apply the mortar by means of a machine which is made for the purpose.

In case no boarding is used, a heavy coat of mortar should be applied to the back of the lathing thus completely bedding it in mortar and forming a thick wall partly between the studs, in which the metal lath acts as a reinforcement, while the whole tends to stiffen the frame to a great extent, Fig. 49.

A coat of plastering is an excellent treatment for the exteriors of old wooden houses. When an old house is to be covered, every part should be thoroughly examined and treated according to defects which may be found. Leaks in roof or gutter which will admit water back of the mortar coat must be repaired, loose clapboards or shingles secured, and window casings examined and treated according to taste and judgment as to whether they should show outside the coating or should be covered. Good results are often obtained, if the clapboards or shingles are sound, by stapling the metal lathing directly to the face of butts, the serrated space behind giving a key; but a safer method is to fur vertically with wood or metal.

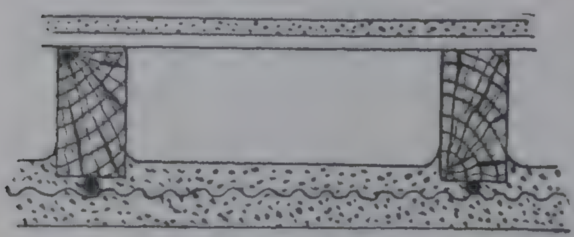


Fig. 49. Backing Coat of Plaster Where Boarding Is Not Used

Concreting the Cellar. When the last of the inside plastering has been completed, the concreting of the cellar should be begun so that it may be drying out with the plastering. For this the best cement must be used, mixed in proper proportions, puddled, and troweled to a perfectly level surface. A good mixture for cellar concreting is 1 shovelful of Portland cement, 3 of sand, and 6 of broken stone or screened pebbles, with a top dressing of cement and fine stone from which the dust has been screened.

Waterproofing. If the house is located in an especially wet place, it may be necessary to use other than the ordinary means of a well-built wall and strong concrete floor to withstand the pressure which ground water sometimes exerts against the cellar. In this event a waterproofing compound must be combined with the cement, and in extreme cases a lining of tarred felt should be used, mopped to the outside of the walls and previously run under the wall on top of the footing, Fig. 50, to be continued over the whole cellar bottom on a rough bed of concrete. This surface is then mopped with pitch and over it is laid the finished concrete of the cellar.

Fireplaces. While the plastering and concreting are drying out, the fireplaces are usually finished. These are to be of bricks and should be built with a splay of from 6 to 8 inches to the sides. (See Fig. 36.) The back lining is built up plumb for about six courses and then inclined toward the front until an opening of about 2 inches only is left, Fig. 51. If a flat arch or level bricks are used for the opening there should be provided a wrought-iron bar or, better, two bars, which must be let up into the underside of the bricks so that they may not be seen. Care must be taken to see that fireplaces are set in the exact center of chimney breasts and rooms; also that the faces of the bricks are in the required position, usually flush with the plaster line, although this may be varied to allow for differences in the form of mantel desired.

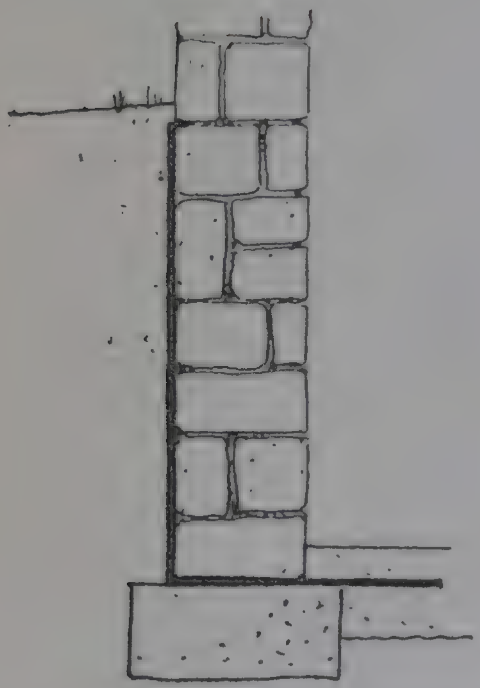


Fig. 50. Section of Cellar Wall Showing Method of Waterproofing with Tarred Felt

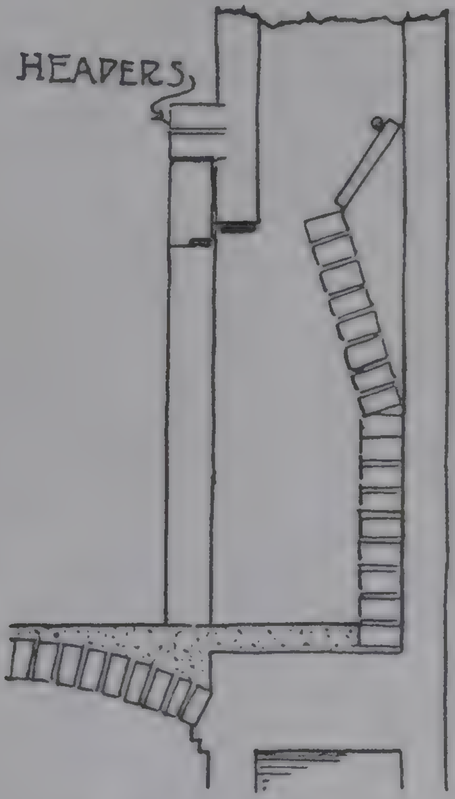


Fig. 51. Section of Fireplace Showing Construction

Dampers and Throats. Cast-iron dampers and throats for fireplaces may be bought and set into place, the commonest type being the *tip-and-slide* damper, Fig. 52. This consists of an iron frame containing a sliding damper for use if little draught is required, the entire inner section tipping back to open the whole width of the fireplace. Care should be taken that the flue is not drawn in so quickly that there is not room to tip the damper, and that the damper is set high enough so that the usual hanging toggle does not show. More complicated dampers have the opening and closing controlled by a rod connecting with a milled head or thumb piece on the surface, and so-called "throats" combine the damper with a short upstanding or slanting duct to connect with the flue.

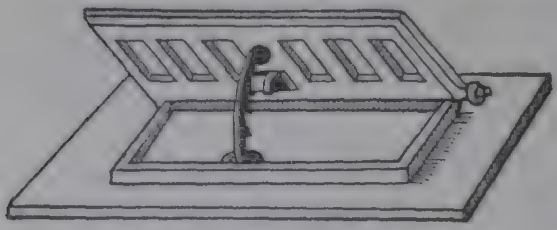


Fig. 52. Tip-and-Slide Damper for Fireplace

PLUMBING

PIPING

Soil Pipes. As soon as the plasterers have removed their stagings from the house, the plumber can at once complete the piping. In some cases it will be necessary to run the main soil pipes concealed behind the plaster, but it is much better if they can be in plain sight. Extra heavy pipe is called for, to be plain and painted on the outside with red lead. These pipes should be tested for sand holes before delivery; since they are plain, any imperfections in the casting may be readily seen; this would not be the case if the pipes were asphalted, as they usually are. The joints of the soil pipe will need special watching to see that they are not slighted in any way. All the joints must be made of oakum, driven in tight, and finished with melted lead which will be poured around each joint and then thoroughly calked after the pipes are in position, Fig. 53. It is never advisable to complete the joints before securing the pipes in place, for the jar of this handling may loosen the lead. The pouring-in of melted lead will not secure a tight joint as the lead shrinks away upon cooling and it is necessary to force it again into contact with the pipe. This is the object of calking, and if well done the lead in the joint will show marks of the iron all around.

Lead Pipes. Lead pipes will be most easily examined on delivery, when the ends of the coil will be stamped with some figures or letters to denote the weight per foot. After the pipe has been cut it will be next to impossible to tell by appearance whether or not it is the right weight. All lead pipe which is not new or which shows unequal thickness should be rejected. The running of lead pipes must be carefully watched and boards should always be put up, against which or upon which the pipes may be securely fastened. Lead pipes which are run vertically should be fastened by hard metal "tacks", which are soldered to the pipe at intervals of about three feet. Unless this rigid fastening is made, the pipes will "crawl" and droop because of alternate contraction and expansion. Horizontal pipes may be secured by bands but should have a continuous strip of wood to support the entire length, or they will in time sag and form a hollow place, from which the water cannot be drawn when pipes must be emptied. The pipe should be made to rest upon the straight support and never be allowed to take an upward bend in its level course, as this soon becomes filled with air and would eventually stop the flow of the water unless punctured at the highest point.

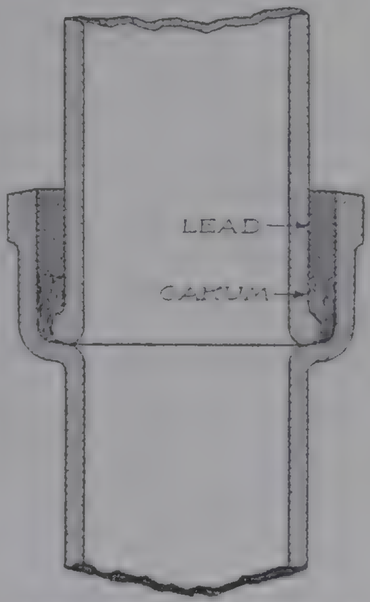


Fig. 53. Section Showing Joint of Soil Pipe

All the joints in lead pipes should be wiped joints, as specified, and no cup joints, which are more easily made but are not so strong, should be accepted. The joining of lead and iron pipes must be made by wiping to the end of the lead pipe a strong brass ferrule which can be calked into the iron pipe. The superintendent must watch carefully to see that this is done for it is a great temptation to many plumbers to putty the lead pipe into the socket of the iron pipe.

Brass Pipes. For a hot-water system, brass pipes should be used since they are not affected by the alternate warmth and chill of the water which would cause lead pipes to sag between the supports. Indeed, if the additional expense is not too great, it is worth while to make all the supply pipes of brass, which can be obtained either plain or coated inside with tin. If brass piping is used, it must be put up so that the angles and bends are free to move a little, or else the expansion and contraction will strain the fittings and produce leaks. The effect which the water will have upon the pipes is a matter which should be considered, but it can be determined only by local examination, and recommendations as to the use of piping must be made with reference to the analysis of the local water supply. If brass piping is used, it should be semi-annealed and specified as "iron size"; that is, the thickness must correspond to that of iron pipe of similar size, as distinguished from so-called "plumbers' tubing", the use of which is not to be recommended.

Iron Pipes. If the cost of brass piping proves to be excessive, a good quality of iron pipe may be substituted where there is danger of the corrosion of lead or of its bursting by great pressure. Iron pipe may be obtained with a lining of block tin, which forms a pure and very satisfactory channel, or with a less expensive galvanized or zinc coating. The directions given for piping with brass must also be followed in running iron pipe, and, besides, precaution must be taken against condensation which will take place upon iron pipes in warm weather, because of the fact that iron conducts heat so rapidly. This condensation may be so great as to trickle down and cause damage to paper or decorations. Where there is this danger, the pipes should be run in tubes of zinc which will conduct the water to a safe outlet. This precaution should be observed, even in the case of lead or brass piping, when costly decorations or papers are liable to injury from bursting or leaking pipes.

General Rules for Running Pipes. The fastening and joining of all pipes should be carefully watched to see that they are run in straight lines, with free angles. The hot-water pipes should be separated by a little space from the cold-water pipes so that there will be no transmission of heat from the former to the latter. Every pipe must be run so that it will pitch toward one of the faucets or waste cocks, which must be provided in convenient places and in sufficient numbers to shut off and drain both the hot- and cold-water pipes of any given part of the house, as well as of the whole system.

Waste Pipes and Traps. The waste pipe or outlet of every plumbing fixture must have, as near as possible to the fixture, a trap to prevent foul odors and sewer gas from escaping. The simplest form of trap, and in its improved form one of the best, is shown in Fig. 54. This trap, made of nickeled pipe or an extra heavy lead pipe, has a plug at the bottom to provide for cleaning.

The vent stack *A* is connected with the trap near the water seal, so that when a large volume of water is passing through the trap the tendency to produce a vacuum and draw out the water, thus destroying the seal, is prevented by the vent. This is accomplished by continuing *A* through the roof. In case there are two or more floors and one fixture is connected with the same pipe, a revent system is necessary; otherwise the water passing from the upper fixture closes the pipe and breaks the vent through *A*. The revent *B* is carried horizontally across to the main stack *M*, through the prime vent *C*, and thus has access to the outside air. A partial vacuum is created in the soil pipe, and the outer air, rushing in to fill the void by the easiest way, will force the water out of the trap below, Fig. 55. This is a real danger and should be guarded against.

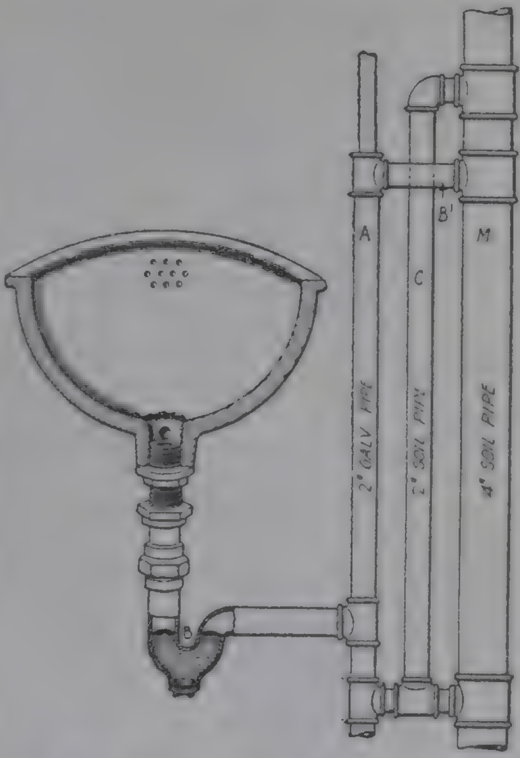


Fig. 54. Section of Plumbing Showing Use of S-Trap

The improved trap which obviates these perils has an inlet at the highest point of the trap *A*. The vacuum in the outlet pipe will be filled from this source without disturbing the water in the trap. This inlet pipe must, of course, be carried to some main air pipe; it is therefore customary to run beside the main soil pipe a line of vent pipes to which the different trap vents are attached, the main vent usually starting from the base of the soil pipe and entering it again above the highest fixture.

Another way of guarding against siphonage is to make the trap so large that enough water will drain back from the outlet and sides of the trap to restore the seal. This is called a "pot" or "cesspool" trap. City plumbing laws generally require the venting of traps, and it should be done in all cases.

Testing. When the waste and air pipes are all in place and the connections for the various fixtures are put in, the whole system should be subjected to an effective test. The simplest and most efficient one to employ at this stage is the water test called for by our specifications, which should be carried out in the presence of the superintendent. It consists in closing all openings in the pipes and filling the whole system with water, either by attaching a hose at the bottom or by filling from the top. If the water does not lower in the pipe after standing ten or fifteen minutes, the system may be pronounced tight. If, however, the water level drops, there is evidently a leak somewhere which must be sought out at once. In a tall line of piping the water pressure will be such that defective joints or sand holes will be discovered by a stream of water, or at least by the trickling of water down the pipe. Imperfect joints in the cast-iron pipes may be remedied by more careful calking, but sand holes cannot be repaired. The defective pipes must be replaced, and the new pipes again tested until the system proves absolutely tight.

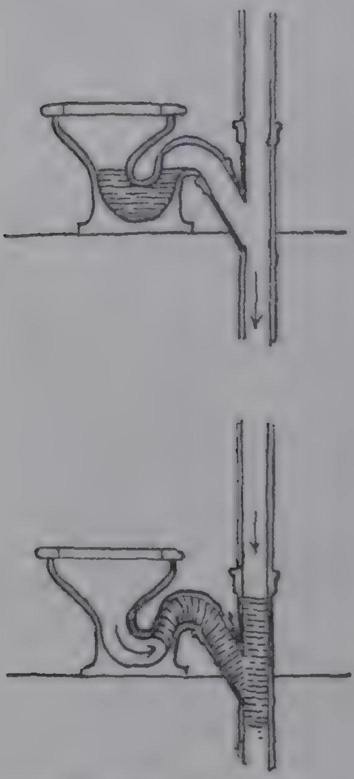


Fig. 55. Siphonage of Trap

After all fixtures are set and all connections completed, another test is usually made. This may be the "peppermint test" or the "smoke test". In the former a vial of oil of peppermint, which is sold sealed for the purpose, is taken to the roof and emptied into the top of the soil pipe. A quantity of hot water is immediately poured in and the top of the pipe closed by stuffing in paper or rags. The vapor, charged with the odor of peppermint, is thus unable to escape and will penetrate the whole system. All drain, air, or waste pipes, and connections are immediately examined and any odor of peppermint detected will be evidence of a defect which must be remedied. Great care must be taken in applying this test. It should be made by separate persons, one outside and one inside the house, and no direct communication should be held until the test is pronounced satisfactory.

Another method of applying the peppermint test is to close all vent pipes and vaporize the oil of peppermint in the receiver of a small air pump, and then to force the vapor into the system under pressure. The receiver is provided with a gage so that any leak will cause a fall in the mercury and can then be located by the odor of the peppermint.

The smoke test is required in the building of our house. This is made by closing the system as for the peppermint test and forcing into the pipes, by means of a bellows, smoke from oily waste or some similar substance. When the pipes are filled, a slight pressure is produced, which is shown by a float that rises and remains in this position if the joints are tight. If there is a leak, the float falls as soon as the bellows are stopped, and the leak may be located by the issuing of smoke from the joint. Special machines are to be bought for making these tests, which should be carried out in the presence of the architect or superintendent.

HOT-WATER SUPPLY

Attic Supply Tanks. In New England it is customary to supply the bath boiler from a separate tank in the attic, this tank being filled from the regular house service with a ball cock to regulate the flow. The supply from the boiler to the various fixtures is made to return again to the boiler for circulation, which allows hot water to be drawn at once at each fixture. From the highest point of the circulation a small "expansion pipe" is run to the tank and turned over the edge to discharge just above the water line, in order to allow the steam and froth from the boiling of the water to escape into the tank. This tank should be supplied with an overflow to some convenient fixture. Outside of New England, the tank is generally omitted and the boiler filled from the house system, but this requires a strong boiler, usually of galvanized iron, and is not so satisfactory as the expansion system.

Range Boilers. Hot water is usually provided for by connecting the boiler to a water back or heating coil installed in the fire box of the kitchen range, the supply of hot water depending upon the use of the range for cooking purposes. Another method is to install the boiler in the cellar and to connect it with both the furnace and a separate heater. In this case, the continuous furnace fire in cold weather keeps a constant supply of hot water during the winter months, and the piping is so arranged that when warm weather comes, the furnace can be disconnected and the separate heater used as needed.

Range boilers are made of copper or of plain or galvanized steel, and they may be set vertically or hung horizontally, as the location requires. The most common type is the vertical boiler of from 30- to 60-gallon capacity, set on an iron stand beside the kitchen range, and connected to a cast-iron water back or a pipe coil in the range, Fig. 56. The cold-water supply is piped into the boiler at the top; it discharges near the bottom of the boiler, and passes thence into the water back; there it is heated and returned, either to the boiler by a pipe higher up, Fig. 57, or sometimes to the outlet pipe above the top of the boiler.

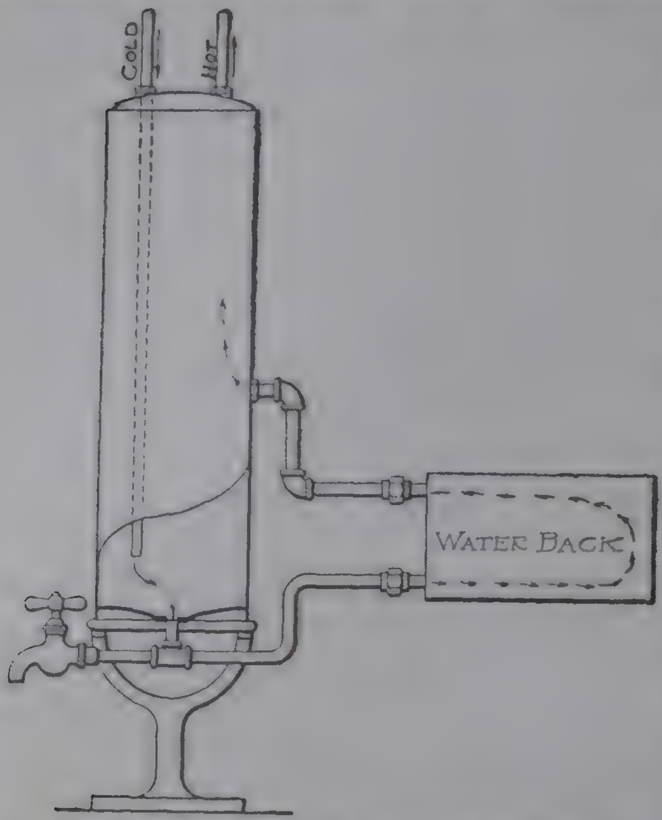


Fig. 56. Typical Range Boiler for Supplying Hot Water

Gas Heaters. Where gas is available for heating, one of the various forms of gas heaters may be employed, either alone or in connection with the range, furnace, or other coal fire. The simplest type of heater keeps an ordinary gas flame burning all the time if a constant supply of hot water is desired; or, if the hot water is wanted only periodically, the flame may be extinguished and relighted, as occasion requires.

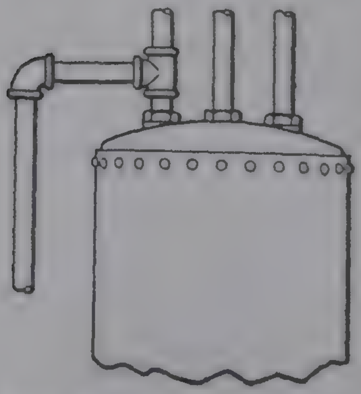


Fig. 57. Detail of Water Tank Showing Connections

Other types contain automatic devices for regulating the size of the flame according to the use of the water. These heaters usually have a small pilot light which burns when water is not being heated; and the pilot light and burners are so arranged that the opening of a faucet in any part of the hot-water system releases a pressure which opens the gas valve, and lights the burners. When the water has reached the proper temperature and the faucet is closed, this operation automatically shuts off the burners, thus giving a flexible and inexpensive system.

Instantaneous Heaters. Another device is the instantaneous heater, a small appliance which may be placed at the point where hot water is to be used. It consists of a coil of brass, copper, or some other good conductor, through which cold water from the main is made to pass slowly, subjected to direct contact with a range of gas flames, Fig. 58. These burners are ignited from a small pilot light which is swung into contact when hot water is required.

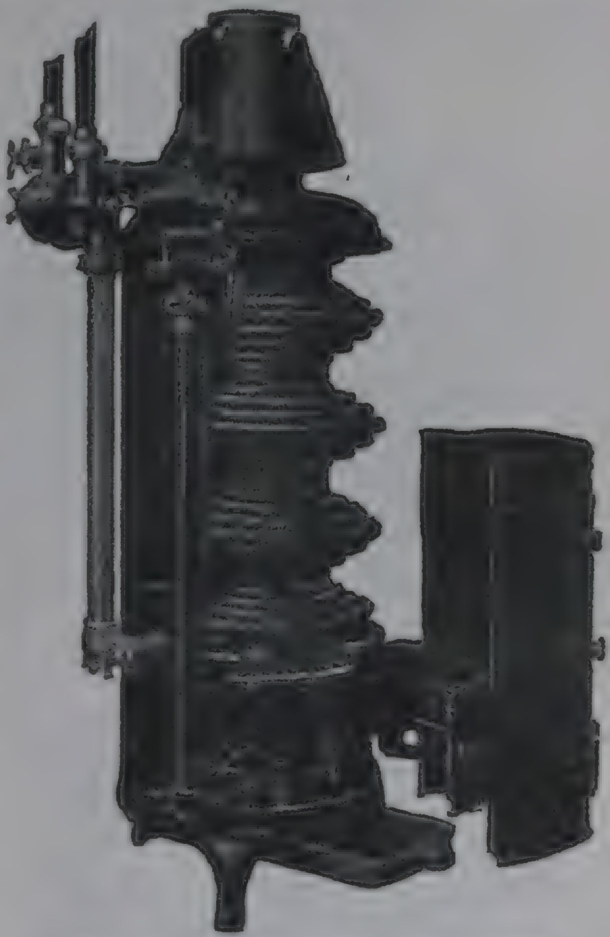


Fig. 58. Part Section of Instantaneous Gas Heater

Courtesy of The Humphrey Company, Chicago

PRIVATE WATER SUPPLY

Compression Tanks. Where no public water service is available, a private supply becomes necessary. This may be secured by sinking a well and installing a compression tank in some convenient place to be filled by a hand or power pump. The pump forces the water into an air-tight tank until the air is compressed at one end to a considerable degree. The objection to a hand pump lies in the fact that it is necessary to keep the tank reasonably full to maintain the pressure, and the task of keeping it filled is a good deal of a nuisance, to say the least. A much better way is to install a pump deriving its power from electricity or gas which can be more or less automatically controlled, thus relieving the owner of the bother of watching the compression.

Special Systems. Other systems for the delivery of water under pressure are to be found, varying principally in adaptation, and most large firms handling pumps are ready and willing to make recommendations to fit particular cases.

PLUMBING FIXTURES

Water Closets. The standard fixture consists, in general, of a closet in one piece, supplied by a sure and quick flow of water, and emptied by a simple and ample discharge. The superintendent should see that the quality and pattern are as called for by the specifications, that they are perfect in every respect, and set up in a workmanlike manner.

Types. There are several types of closets from which to choose. The simplest of these is the *short hopper*. This consists of an earthenware bowl, Fig. 59, and a trap, the latter being sometimes made of earthenware and sometimes a lead or iron trap to which the bowl is bolted, Fig. 60. The contents are washed into the soil pipe by a discharge of water all around the top rim, which is curled over and perforated or brought to a narrow opening. An improvement of this form is the familiar pattern known as the *wash-down* closet, in which a deeper trap and a larger water area is formed than that made by the regular hopper and trap. This closet requires a large flush of water to remove the contents and is somewhat noisy. To overcome this and to assist in the discharge as well, the plain siphon type, and the siphon jet type, Figs. 61 and 62, have been designed. In this closet a small inlet in the bottom of the basin is connected with the flush pipe, so that when the bowl is flushed a jet of water is projected upward, which assists in removing the contents of the basin and also in filling the outlet. The latter is contracted somewhat in order that the flow of water may fill it completely and produce on a large scale the vacuum previously described in connection with the S-trap, so that the pressure of the air upon the water in the basin helps to push out the contents. An

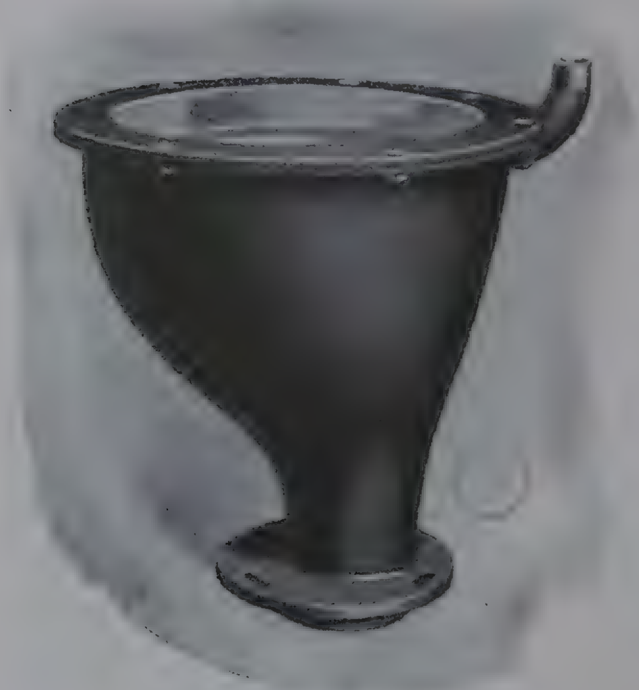


Fig. 59. Simple Iron Hopper
Courtesy of Crane Company, Chicago

objection to the jet is found in houses which are to be left unoccupied during the winter, since the water which is to be thrown out to form the jet remains in the bowl, even when the trap has been emptied, and requires especial attention to avoid being frozen.

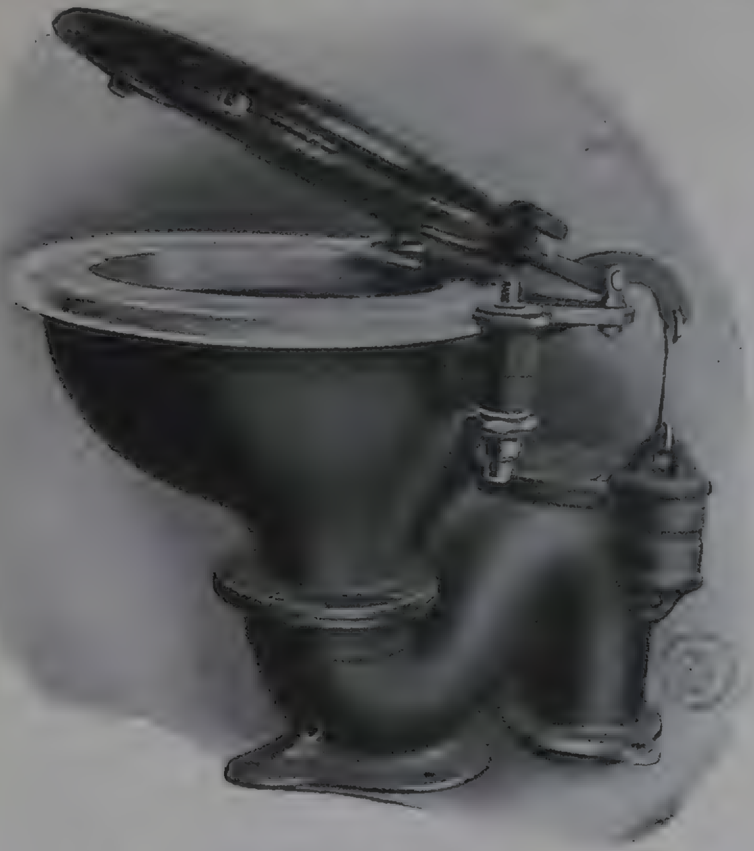


Fig. 60. Oval Flushing Hopper with S-Trap
Courtesy of Crane Company, Chicago

Another form of siphon closet produces the siphonic action without the jet by making a sudden turn in the outlet pipe, which causes the flush of water to fill the pipe completely and to produce a vacuum with the same result as described. A type of closet called the *washout* closet was formerly much in vogue, Fig. 63, but it is not so positive in its action as the others and is less popular than formerly.

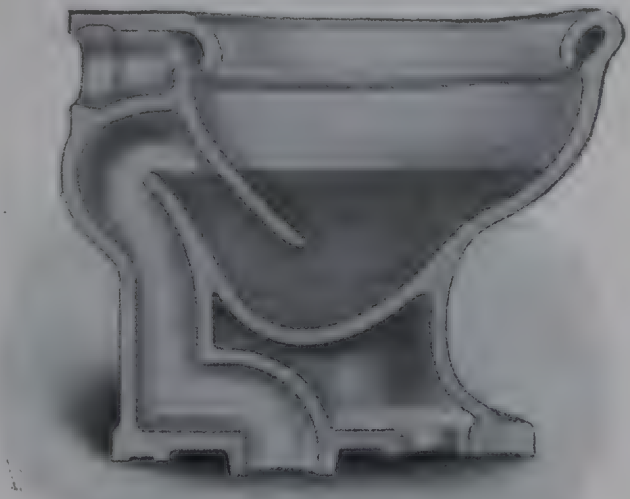


Fig. 61. Section Showing Typical Siphon Closet
Courtesy of Crane Company, Chicago

Connections and Vents. Close attention should be paid to the connection between the closet and the soil pipe, since this connection, except in the case of the hopper closet with metal trap, will come on the sewer side of the trap and must be made absolutely tight. Some of the best closets are constructed so that the connection shall be under water and any leak will at once betray itself.

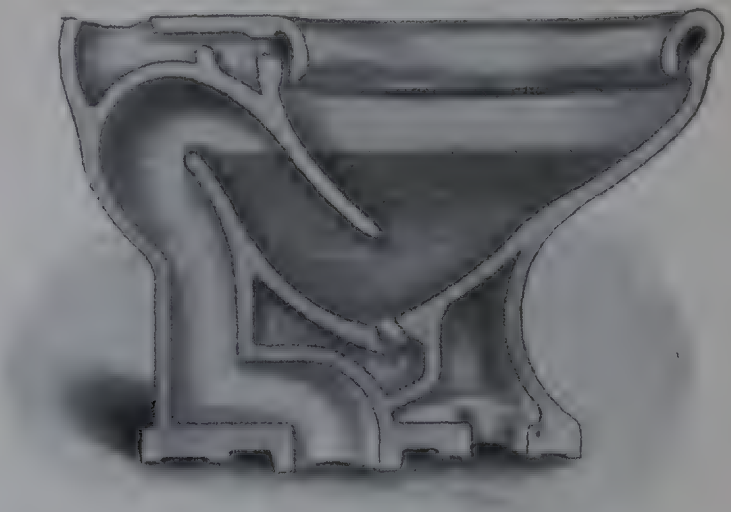


Fig. 62. Section Showing Typical Siphon-Jet Closet
Courtesy of Crane Company, Chicago

Another patented connection retains about a pint of water in a ring where the connection is made, which will appear upon the floor if the connection is not perfect. The connection from this point to the soil pipe is usually made with a lead bend, calked, by means of a brass ferrule, into the soil pipe.

All closets should be provided with a "local vent" outlet, a tube which extends from the upper part of the basin and to which a galvanized pipe may be attached and carried to the nearest warm flue for the ventilation of the basin; all traps, especially where the discharge of higher fixtures may create a vacuum in the soil pipe, should be vented to the main stack of vent pipes.

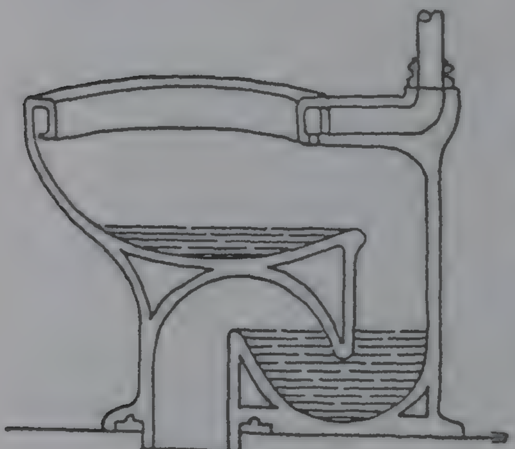


Fig. 63. Washout Closet

Tanks and Flushing. The usual way of providing for a sure supply of water to flush out the closet has been to fit up over it a copper-lined tank supplied from the house service and regulated by a ball cock. The operation of flushing the closet is performed by pulling a chain or rod which raises a heavy plug from the upper end of the flush pipe and causes a more or less prolonged flow of water, when the plug again seats itself and the tank is refilled, Fig. 64. This operation, simple in itself, is productive of considerable noise, and there are on the market many devices aimed to secure an ample flow with a minimum of noise. Another form of tank, and one especially valuable where height is limited, is called the *low-down* tank, Fig. 65, in which the loss of power of gravity is made up by enlarging the supply. These are very satisfactory in their operation.

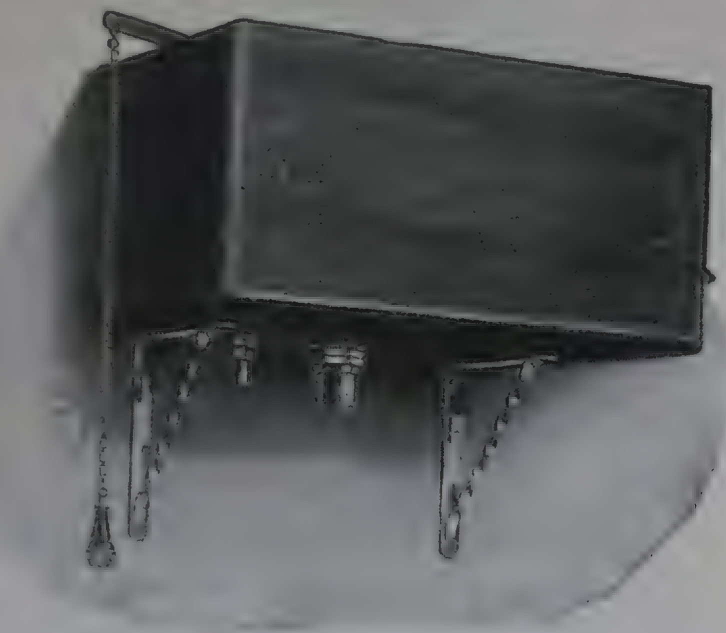


Fig. 64. Elevated Tank for Flushing Closet
Courtesy of Crane Company, Chicago

A newer and increasingly popular form of flushing closets is by means of a valve, Fig. 66, which delivers water directly from the general service, or from a special supply, and then closes automatically. These valves are put upon the market by different dealers under various names, but are all nearly identical in principle. They were formerly installed where many closets were to be supplied or where the presence of any kind of tank was undesirable, but they are coming more into favor for general usage and are called specifi-

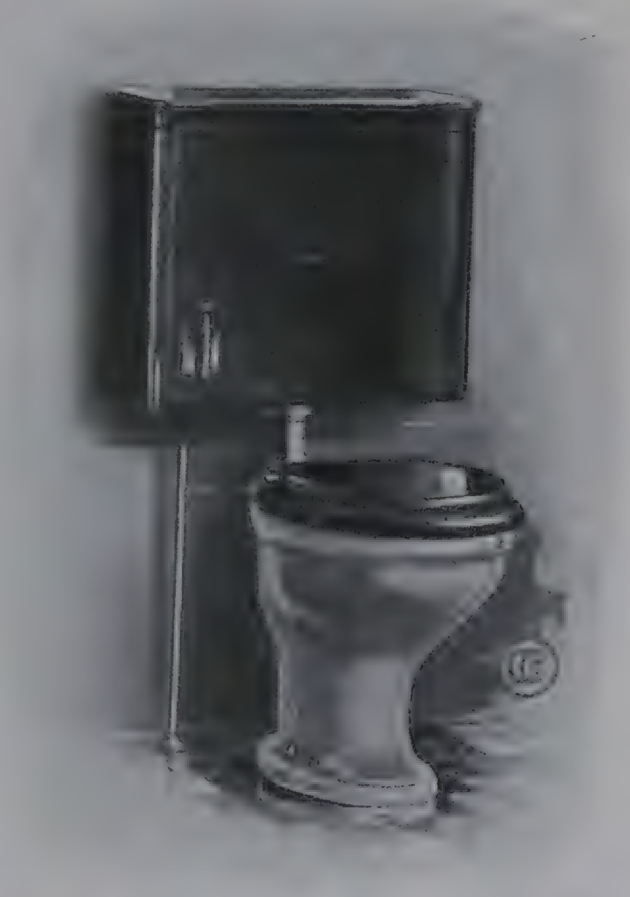


Fig. 65. Flushing Closet with Low-Down Tank
Courtesy of Crane Company, Chicago

cally *flush valves* or *flushometers*. They have the advantage of doing away with the separate tank for each closet. The action consists in depressing or lifting the lever, *A*, Fig. 66, which permits the flow of sufficient water to flush the closet properly, and then closes automatically, causing very little noise. To insure a good flow when flush valves are used, a larger pipe must be run than is required to supply a tank. Some of these valves are operated by the pressure of the flow of water in the pipes upon the valve, others by a spring control operating noiselessly in an oil chamber, and both kinds can be regulated to give as much or as little flow as is desired.

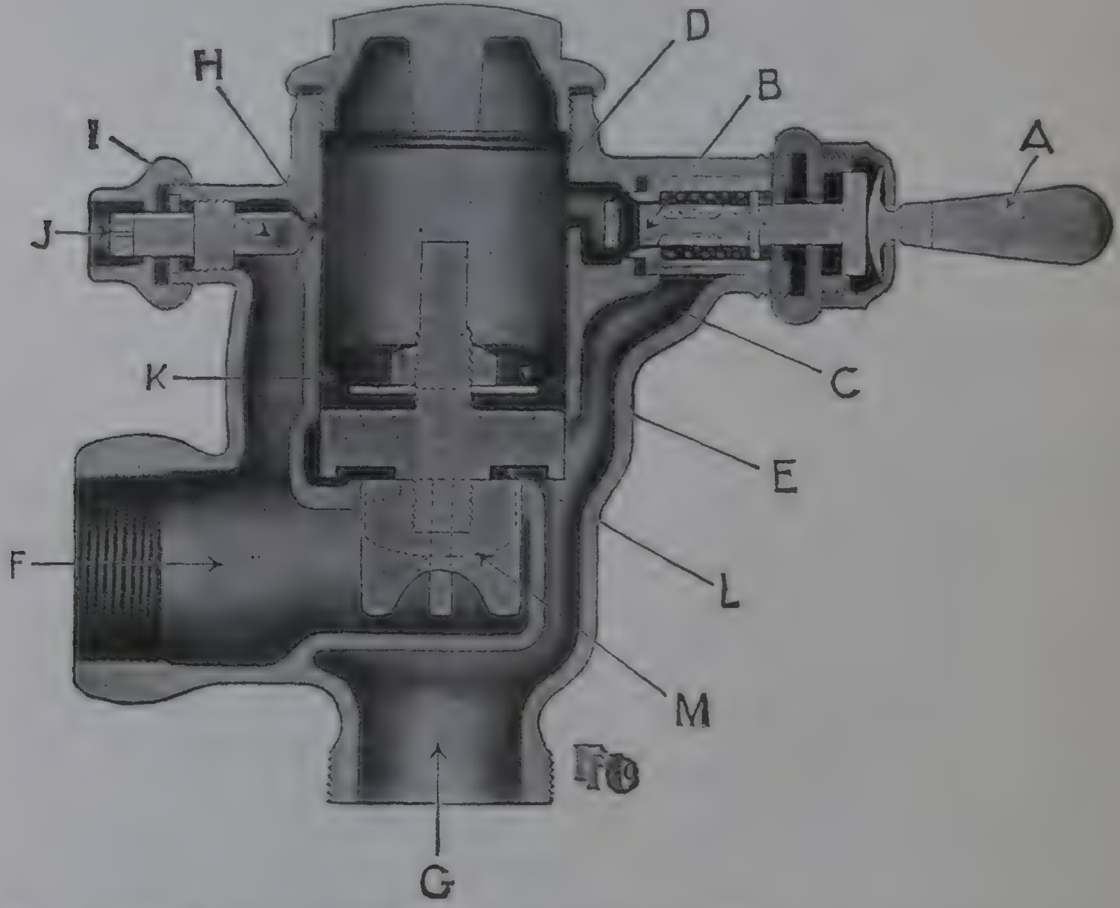


Fig. 66. Section of Boyle Flushing Valve. A—Oscillating Handle; B—Release Stem; C—By-Pass; D—Cylinder; E—Piston; F—Water-Way to Valve; G—Water-Way to Closet; H—By-Pass; I—Regulating Screw; J—Loose Key; K—Leather Washer; L—Leather Seat Washer; M—Refill Disk

Courtesy of Federal-Hueber Company, Chicago

When this form of flush is under consideration it should be remembered that some local plumbing ordinances do not permit the use of these valves when applied directly to the main supply, but require that a separate tank supply be provided.

Lavatories. Not so much choice is to be found in the selection of bowls and tubs. In the former the main differences are to be found in the overflow and waste. These appliances have advanced from the old-fashioned plug and chain, Fig. 67, to the most advanced form of outside connections, Fig. 68, which is the pattern called for by our specifications.

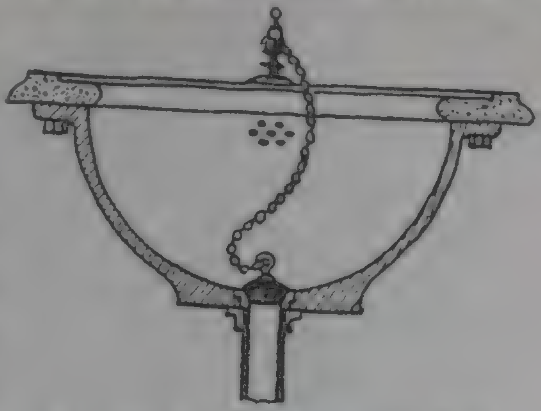


Fig. 67. Section of Lavatory Bowl with Plug and Chain

Pedestal Fixtures. Of greater attractiveness but more expensive than others are the large lavatories which are supported by means of legs or pedestals, the legs being the first deviation from the wall supports and the pedestal a later form, of better appearance, Fig. 69. These are particularly adapted for use in the modern tiled bathroom where no

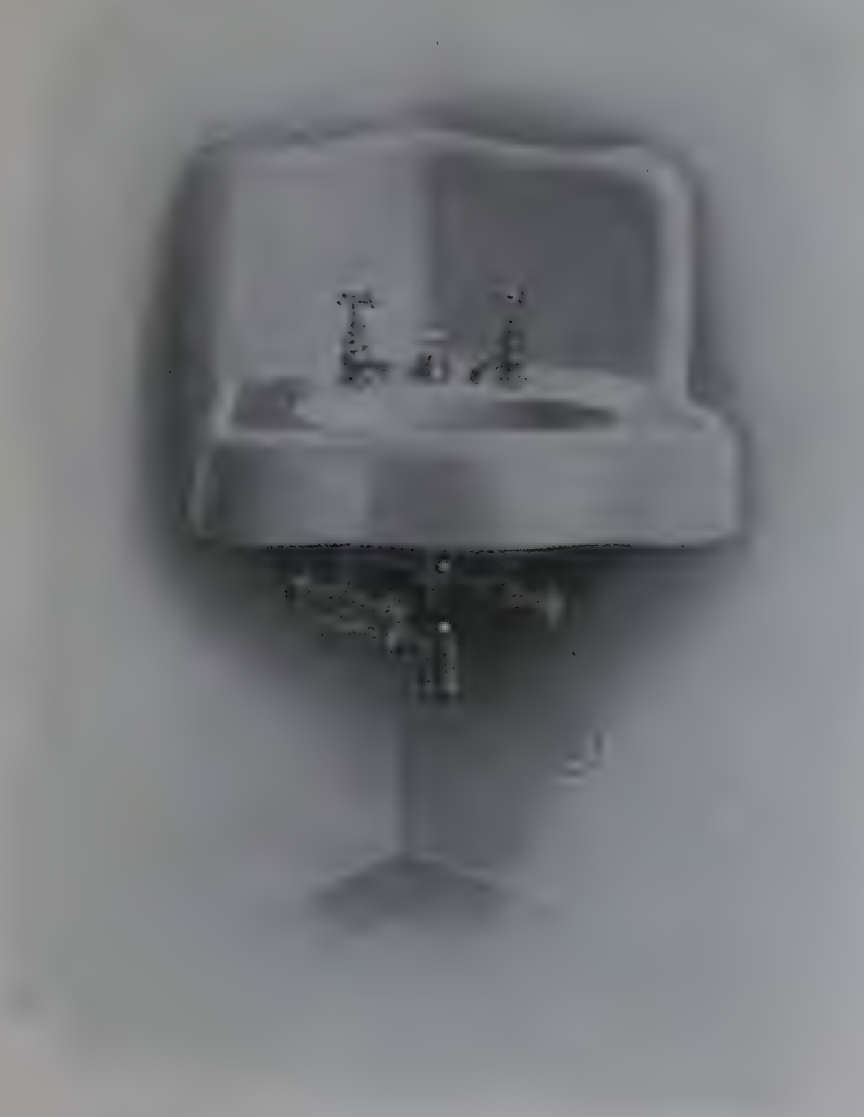


Fig. 68. Modern Lavatory with Outside Connections
Courtesy of Crane Company, Chicago

backpiece is needed. The bowls and tubs are made oval in shape as well as square, being set clear of the wall so as to allow cleaning all around. The pedestals are square, round, or of other shapes, and as plain or as ornamental as may be desired. These fixtures may be obtained in porcelain or enameled iron.

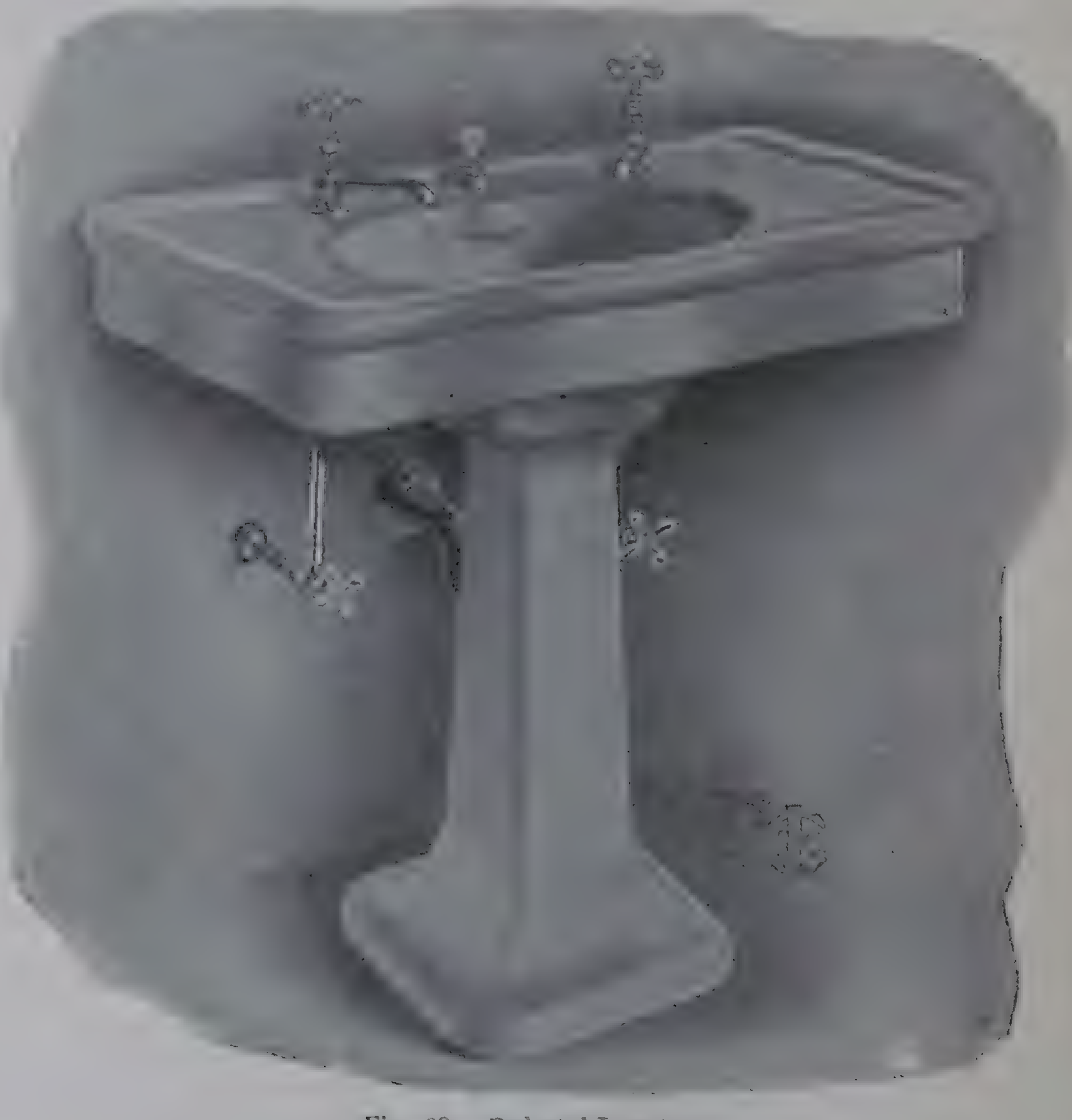


Fig. 69. Pedestal Lavatory
Courtesy of Federal-Hueber Company, Chicago

Bath Tubs. In the selection of a modern tub our choice may range from the ordinary roll-rim, enameled iron tub with painted exterior, which is excellent in all respects, through the various stages of finish and pattern to the solid porcelain tubs of luxurious design and finish. In form there are three general types of tub—those which stand free upon legs, those having solid bases, and those which are built into the wall on one, two, or three sides, or even, if desired, tiled across the front.

The simplest and least expensive kind is set on legs and stands free from the walls and floor far enough to allow washing under and about it, Fig. 70. The tub carried down to the floor does away with washing underneath, which is an advantage, while the tub more or less built-in requires still less attention besides giving a better appearance, Fig. 71.

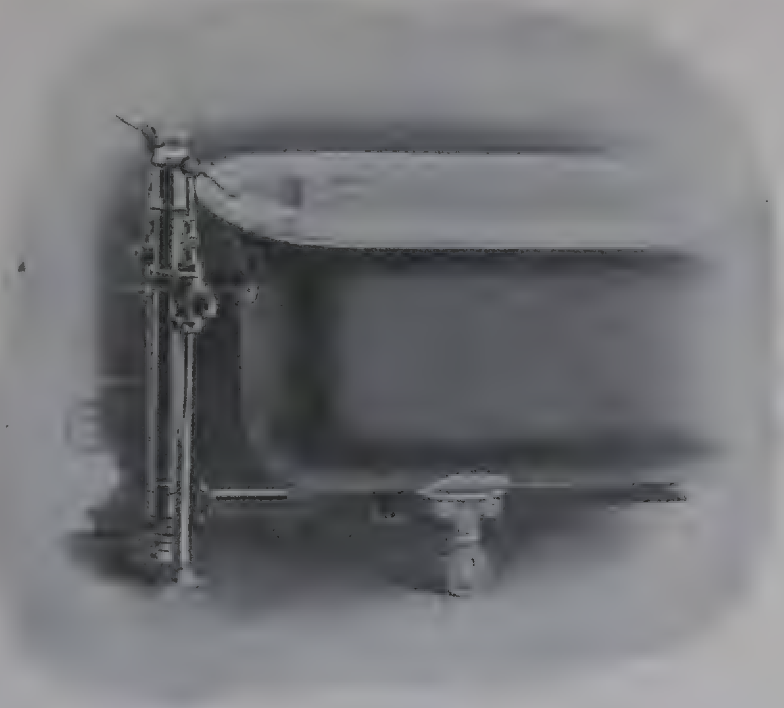


Fig. 70. Typical Bath Tub on Legs
Courtesy of Crane Company, Chicago

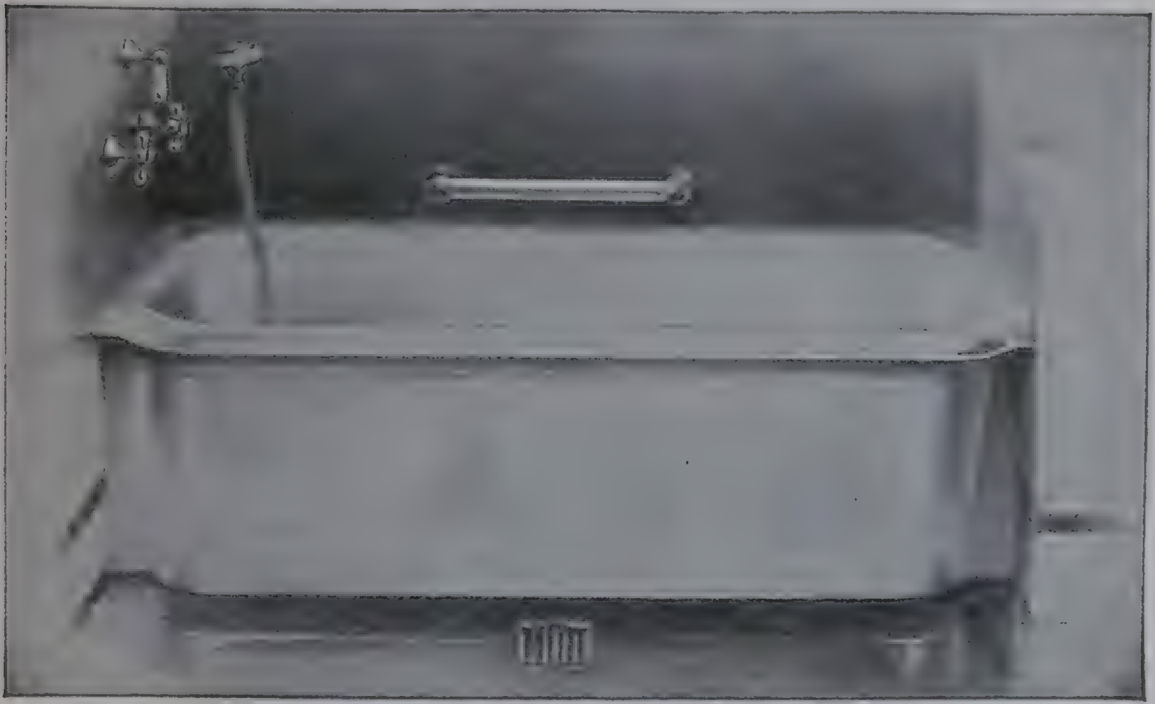


Fig. 71. Typical "Built-In" Bath Tub
Courtesy of J. L. Mott Iron Works, New York City

Both porcelain and enameled iron tubs are left with the outside surface rough, if they are to be covered with tiles or other finish; but if they are to be exposed, the porcelain must be glazed or given a painted or enameled finish. The best finish used on porce-

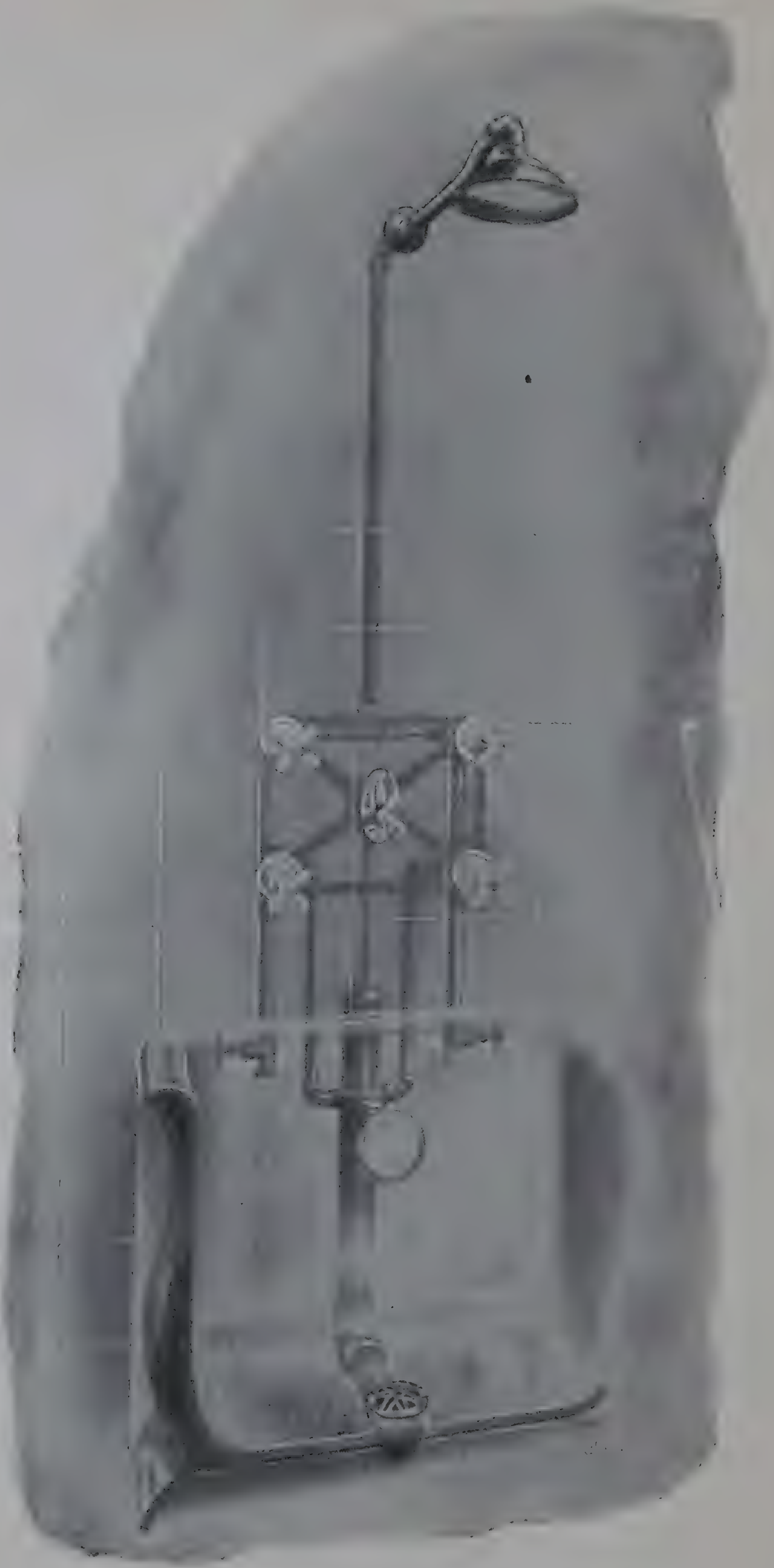


Fig. 72. Overhead Shower for Bath-Tub Connection
Courtesy of Federal-Huebcr Company

lain or enameled iron is known to the trade as "No. 1 Zinc White Finish", and consists of a number of coats of enamel each baked on and smoothed down. This may be decorated with lines or patterns in colors, as desired.

Grades of Goods. Porcelain goods are marketed in two grades with considerable variation in price. "Class A" represents the highest average of production possible, "Class B", a lower average grade but one of fine quality, it being well understood that it is impossible to make large pieces of this ware absolutely perfect, that is, without speck or mark of any kind whatever.

Enameled iron goods are put on the market in two grades, the better of which represents an article thoroughly coated with enamel, applied as evenly and smoothly as the art permits, and under careful inspection during the different processes of manufacture. The second grade includes goods with a coating reasonably smooth, two or three pinholes and minute scratches or lines being allowed. Unimportant blemishes, such as small specks of foreign matter in the enamel, cannot be entirely prevented in goods of either grade.

Shower Baths. The shower bath has become a fixture of general use in the modern well-equipped bathroom. It may be installed either in connection with the tub or as a separate fixture. The simplest way is to extend the hot- and cold-water pipes of the bath supply up to a connecting valve, within easy reach, which controls the flow from a shower head set to discharge into the tub. This valve should be of an anti-scalding pattern so arranged that it is impossible to turn on hot water of an unexpectedly high temperature. A rubber or duck curtain supported from a large ring prevents the spray from splashing beyond the rim of the tub, and the water falls into the tub and drains through the regular fixtures, Fig. 72.

A separate shower—that is, one not over a tub—can be set in a corner of the room at the side, or in a niche or cabinet, receptors being made to meet all conditions. One advantage of a separate fixture, is that it permits the installation of encircling pipes giving needle-baths, liver-sprays, and a variety of showers.

Medicine Cabinets. Cabinets for medicine or toilet goods are an important feature of the bathroom. These may be finished on the outside and hung to the wall, but a better arrangement is to provide a pocket the depth of the studs and to set the cabinet in with little or no projection. Cabinets of different sizes may be bought; some are made of wood and finished with wood, others are made with a celluloid covering over wood. The best cabinets are of enameled metal with adjustable glass shelves, and have a plain enameled door or a mirror set in the face of the door. These are usually set over the lavatory and flanked on either side by lights.

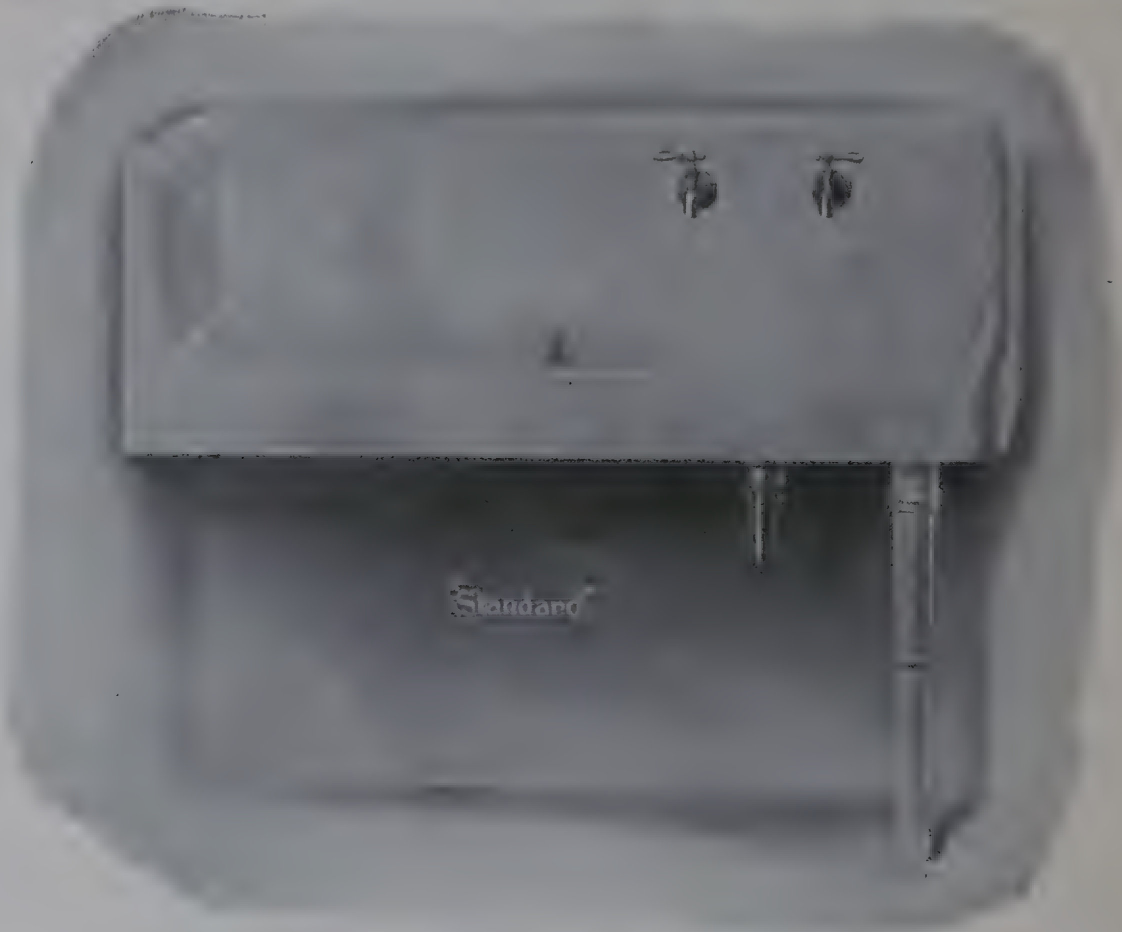


Fig. 73. Sink with Integral Back Piece
Courtesy of Federal-Hueber Company, Chicago

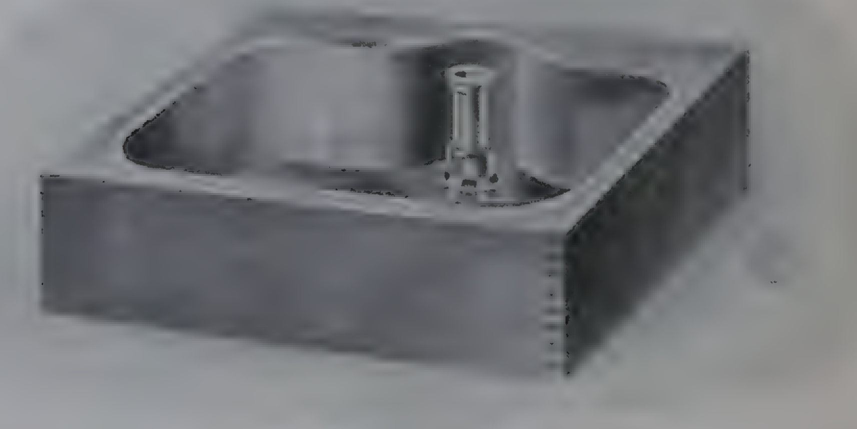


Fig. 74. German Silver or Copper Pantry Sink with Overflow and Waste Connection
Courtesy of Crane Company, Chicago

Sinks and Trays. Not the least important of the plumbing fixtures are the sinks and wash trays, which are subject to harder and more constant use than any of the others. For the kitchen sink the choice will lie primarily between soapstone, porcelain, and iron.

Soapstone sinks, although they have been the standard for many years past, are open to the objection that they present a surface slightly absorbent, which in time becomes dingy from grease and soap. *Porcelain sinks* are very satisfactory but expensive and are used only in costly houses.

In *iron sinks* the choice may be made between a plain and an enameled finish. The old style of plain iron sinks to be set in a wood frame are still on the market and are a good article. At a little more expense sinks enameled on the inside only may be obtained, but a better sink and one of increasing popularity is enameled inside and out. The best type of these is cast with integral backpiece on back and end, Fig. 73.

The pantry or "butler's" sink for the washing of dishes is best if made of German silver, white metal, or copper, Fig. 74. These sinks have a standing overflow, designed to retain a considerable depth of water so that fragile dishes can be washed conveniently and with little danger of breakage. Sometimes the sinks are made to order with a central partition giving separate compartments for washing and for rinsing, and it is possible also to have the drainboards and back covered with the same metal as the sink.

Laundry Tubs. These are made in the same range of materials as the better grades of kitchen sinks and the selection of the particular kind will depend mainly upon the location of the tubs. If the laundry is put in the basement or is a distinct apartment anywhere, a two- or three-part set of soapstone tubs is very satisfactory. If, however, as is often the case, tubs are installed in the kitchen, the style of the kitchen sink may influence the choice of the tubs.

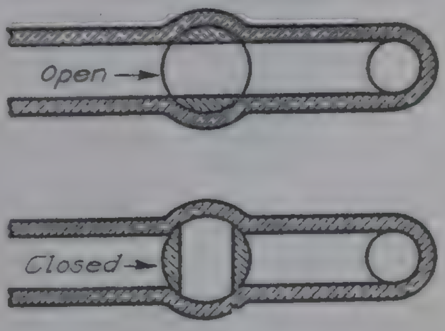


Fig. 75. Section Showing Ground Cock Open and Closed

Cocks. The choice of cocks for the fixtures will lie mainly between two kinds, the *ground cock* and the *compression* or *screw-down cock*. The former consists of a ground plug through which is put a hole in line with the aperture; the cock is opened by turning the plug so that the hole is in the range of the bore, and closed by turning it so that the hole is across the bore, Fig. 75. Although simple and positive in action, this form of cock is open to the objections that when in constant use the plug and socket become worn, especially if the water contains any sand or grit, and if used only occasionally, the adjacent parts become corroded so that the plug refuses to turn. A better form is the compression cock, Fig. 76, in which the spindle is screwed down hard upon the opening and is given a perfect contact by means of a washer of leather or composition, which can be easily renewed when it becomes so much worn that it allows the cock to leak.

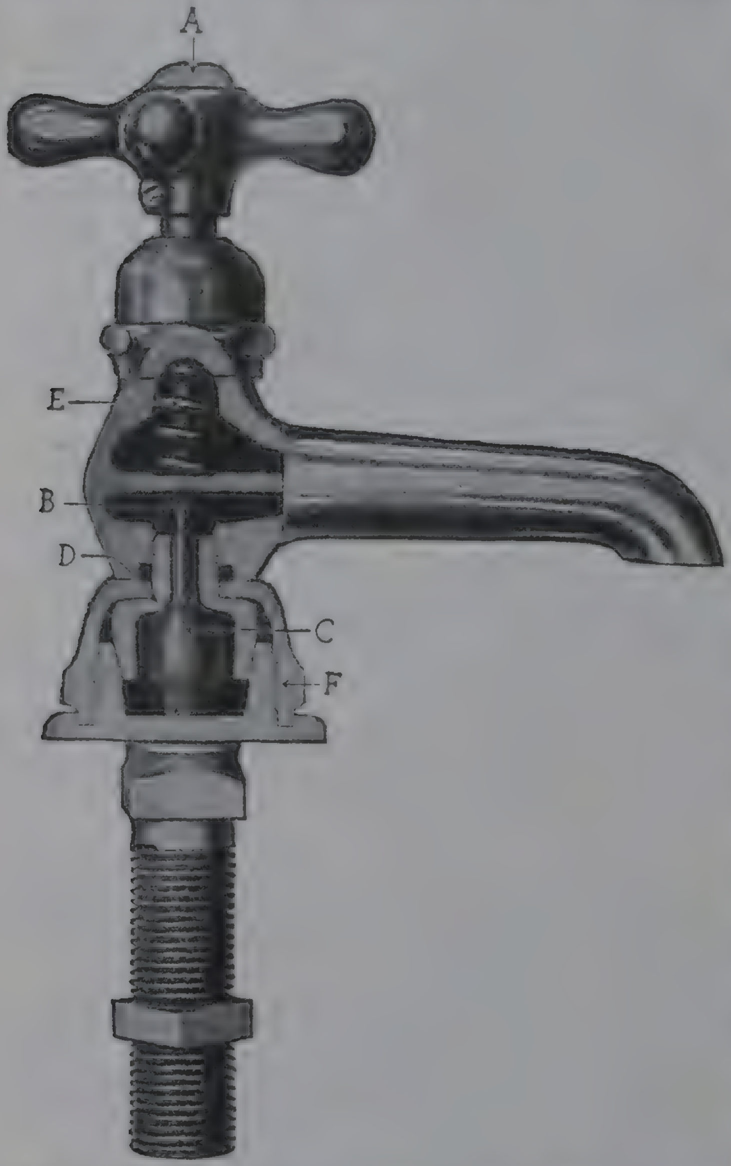


Fig. 76. Section of "Cornell" Self-Closing Faucet. A-Handle; B-Stem; C-Ball; D-Seat; E-Spring; F-Union
Courtesy of Federal-Hueber Company, Chicago

Compression cocks require several turns to seat the valves in place and are in no sense quick closing. If quick closing is desired, it may be secured by using a type known as the *Fuller cock*, Fig. 77, in which a core or plug is operated in the waterway by a quarter-turn of an eccentric stem. There is some objection to the use of quick-acting faucets if the water pressure is high on account of "water hammer", but with ordinary house pressure this is not a serious objection.

Faucets for lavatories and bathtubs may also be obtained of a double pattern that mixes the hot and cold water before it flows from the pipe. The connecting parts are sometimes visible and sometimes concealed by the porcelain or enameled rim, the labeled handles only showing.

The cocks in bathroom and china closets should, in general, be nickel-plated, but the cocks and piping of kitchen and laundry will be more satisfactory if of polished brass. The cold-water cock of these fixtures, and of the pantry sink as well, should have a hose-nozzle termination to facilitate washing the back porch, etc.

Supervision. When the plumbing fixtures have been installed, the superintendent should see that they are properly protected from accident or abuse, until the owner is ready to assume the care of the house.

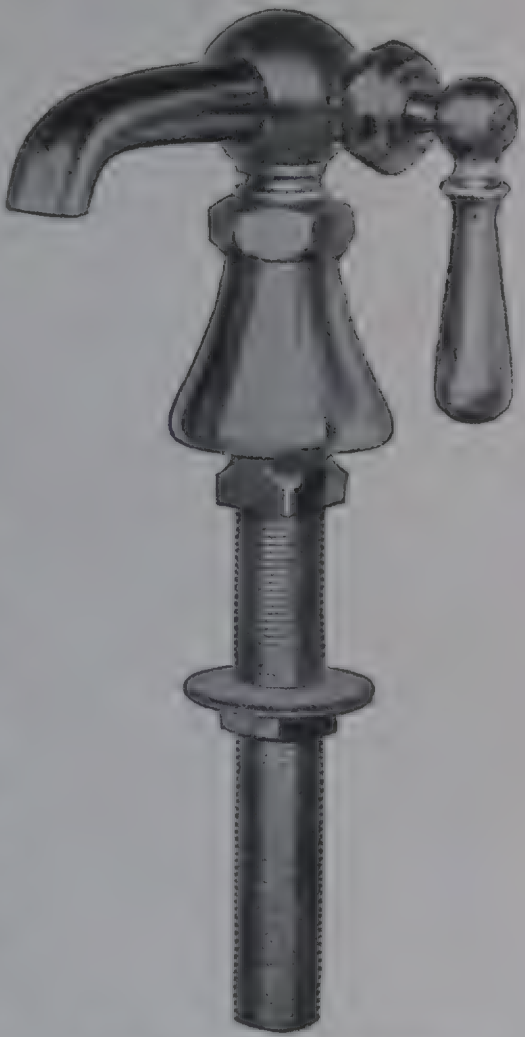


Fig. 77. Fuller Basin Faucet
Courtesy of Federal-Hueber Company, Chicago

HEATING

Systems of Heating. While the plumbing work is being done, another set of men have been putting in the heating apparatus. The selection of the heating apparatus will depend upon local custom, expense, and personal preference. Three principal methods present themselves with some special features to recommend each. These are the hot-air furnace, the hot-water heater, and the steam boiler. The simplest and least expensive to install is the hot-air furnace, Fig. 78, which also has the merit of introducing a continuous supply of warmed fresh air into the house, thus improving the ventilation. Next in cost of installation, is the system of direct steam heating; when once installed, the cost of maintenance is less than the hot-air furnace. This is due in part to the fact that in direct steam heating, the already tempered air of the rooms is simply raised to the desired warmth, and fresh air must be supplied by other means. The system has the advantages of being more easily adapted to the heating of distant parts of the house, and of being positive in its action at all times.

Of greater cost to install, but with some advantages in maintenance, is the system of direct hot-water heating. This is similar to direct steam except that hot water, instead of steam, circulates throughout the system, and herein is one advantage due to the ease with which the temperature can be regulated.

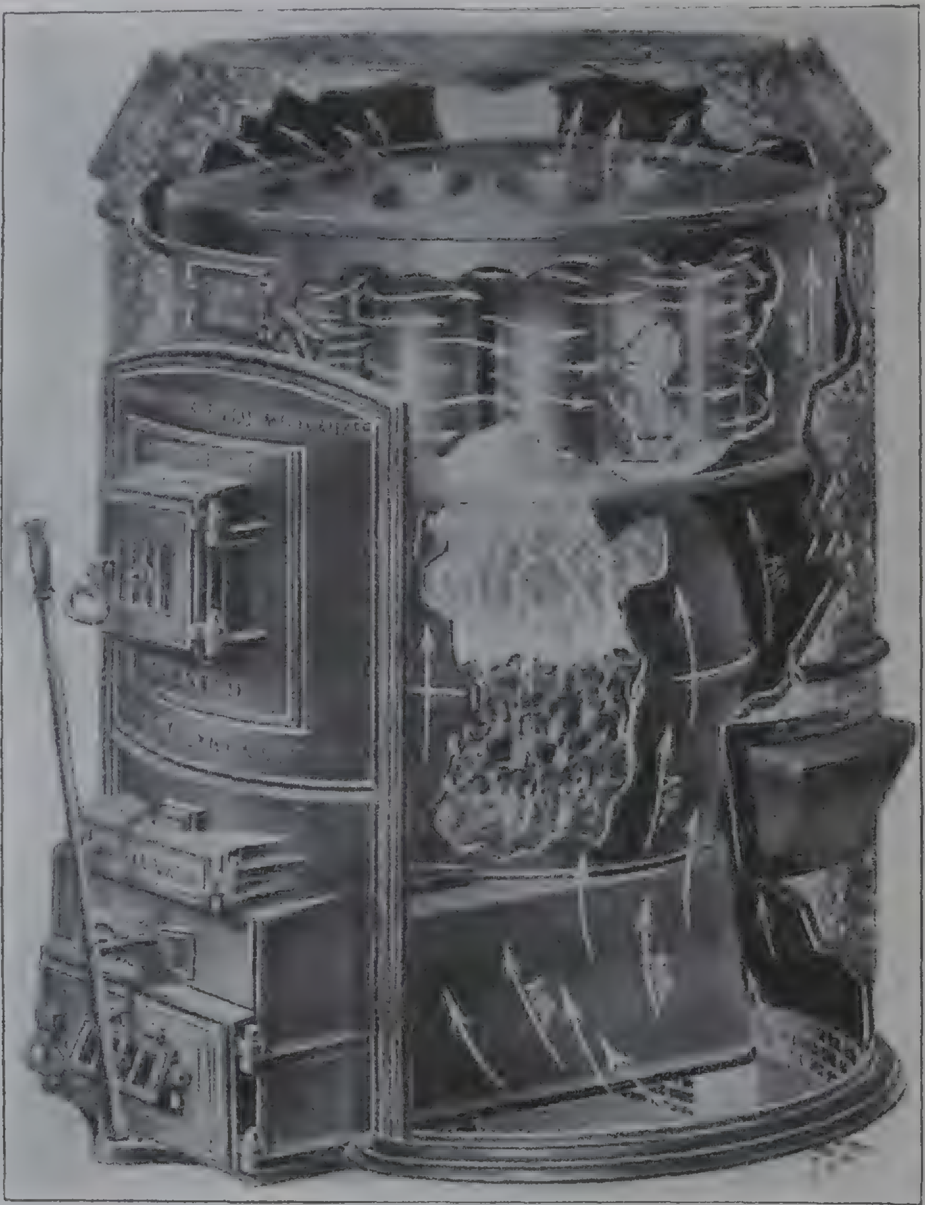


Fig. 78. Stewart "B" Direct-Draft Furnace with Tubular Steel Radiator. Portable Form for Hard or Soft Coal
Courtesy of Fuller-Warren Company, Milwaukee, Wisconsin

Steam is generated by raising water to a temperature of 212 degrees Fahrenheit, and the radiators of a steam heating system are, consequently, always at about the same temperature. Regulation of the heat is secured by shutting off and turning on the steam at intervals, but with hot water the radiation is regulated by the temperature of the water which is in circulation all the time. The latter is a distinct advantage in mild weather as it permits a smaller fire and a corresponding reduction in the consumption of fuel.

In the selection of the heating apparatus, the most important thing is to be sure that the heater, whether hot water or steam, is amply large to do the work. Our client has decided to heat his house by means of hot air, and we have advised him to put in a furnace which contains a good-sized air chamber in order that the rooms may be supplied with a large quantity of warm air rather than a smaller quantity of intensely hot air.

HOT-AIR HEATING

Furnace. For economy of fuel, we find recommended a furnace of the type known as *indirect draft*. In this type the heated gases are ordinarily obliged to pass downward to a radiating chamber at the base and thence upward again before escaping into the chimney, thus giving off a large proportion of their heat. Among other points to be considered in the selection of the furnace is the grate, which should be of a pattern that allows easy disposal of the ashes and clinkers without much disturbance of the fire. The construction of the fire pot is of great importance, and here the choice lies between a heavy cast-iron pot and a thin wrought-iron or steel pot with a lining of fire bricks. The cast-iron pot has the advantage of continuing to give off a considerable heat when new coal is put on, while the brick linings allow the furnace to cool more when the fire is dull. Other desirable features are a large combustion chamber, as the space above the fire is called, and ample heating surfaces so arranged that they will not become deadened by soot. We have selected our furnace not only with regard to all these points but also because of the smoothness of its castings and the evidently workmanlike construction of its joints and working parts.

In locating the furnace, it is necessary to see that the pipes are of about the same length, any differences being made in favor of pipes running north or west. The smoke pipe should be run as directly as possible and should never come nearer than 8 inches to the floor beams overhead. Care must be taken where the pipe enters the flue to make sure that the connections are tight, and that the pipe is not pushed in so far that it cuts off the area of the flue.

Cold-Air Box. The type of furnace chosen is made to set over a circular pit into which the cold-air box leads. An important consideration is the size of the cold-air box which should be of a capacity nearly equal to the combined capacity of the piping—about one-sixth less is the close rule, as the cold air will expand about that amount on being heated. Unless the supply from the cold-air box is ample, there will be danger that the long pipes will draw from the shorter pipes, or that the general flow will be weak and irregular. The opening of the cold-air box is usually placed on the north or west side, as the coldest winds generally come from those directions, but a better way is to carry the cold-air box completely across the cellar with a connection to the furnace at right angles, so that the latter may draw a supply without regard to the direction of the wind. If we build our cold-air box in this way, we shall avoid the very disagreeable experience suffered by all who have built their furnaces in the usual way—that of finding that when the wind is high from the side where the cold air is taken, the chances are that the air is driven through so rapidly that it does not get sufficiently heated, but comes in cold gusts from the registers. On the other hand, when the wind is strong from the side opposite to the single cold-air opening, the suction from the lee side of the house will often cause the air to flow down the registers and out of the cold-air box; in this case there is danger of the already heated air becoming hot enough by further heating to set the cold-air box on fire, if the box is of wood. To guard against such a possibility, it is best, if that can be done, to make all air ducts of galvanized iron, though these are, unfortunately, more expensive. In certain localities this metal construction is required by the building laws, and it is to be recommended in all cases.

Supervision. Beyond seeing that the apparatus, the piping, and the registers are ample in size and designed to heat the house properly, the superintendent should watch carefully to make certain that there is no danger from fire. All pipes which are run in concealed places should be double, or at least well protected by bright tin or asbestos covering, and by the use of wire for lathing over them. The furnace should have above it on the ceiling a circular shield of metal of ample size, or else plastering on wire laths. In running the pipes, sharp bends and sudden contraction or distortion of the pipes must be avoided, and free entrance of pipes to the register boxes must be provided everywhere. The practice of topping pipes or running one pipe to supply two registers, is productive of continual annoyance, as it is almost certain that one register will get the greater part of the heat at the expense of the other. The registers should always be set in borders of slate or soapstone, or in the iron rims which are provided, and they should be free in action and tight when closed.

STEAM HEATING

Another efficient method of heating country houses is by direct steam radiation, which consists in circulating steam through radiators or coils placed directly in the rooms and halls. This may be done under high or low pressure, but the low-pressure gravity return system is generally used for house heating, from 2 to 10 pounds being rated as low pressure. Three systems of piping are used in this form of heating—called the two-pipe system, the one-pipe relief system, and the one-pipe circuit system.

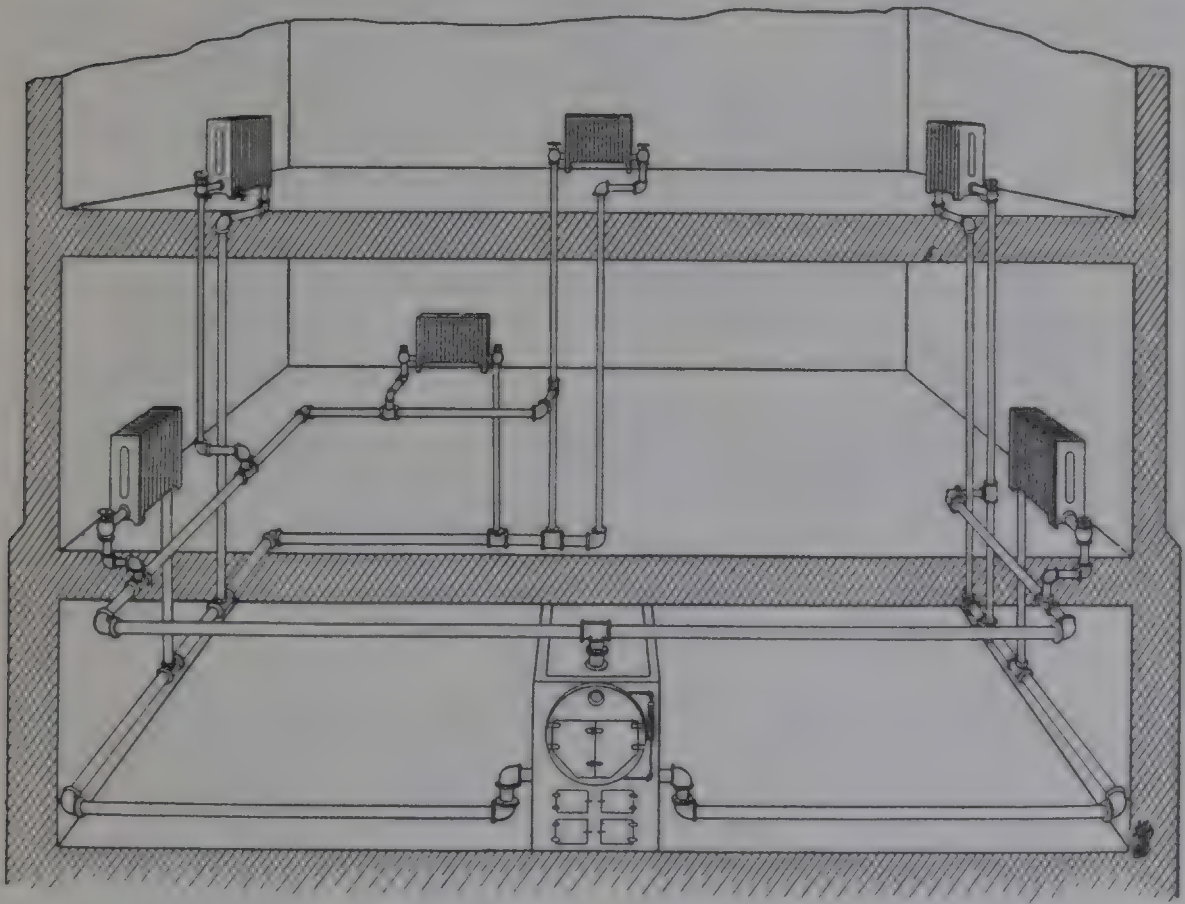


Fig. 79. Two-Pipe Steam Heating System

Two-Pipe System. In the two-pipe system the main pipe is taken from the top of the boiler and carried by branches along the cellar ceiling, pitching gradually down until all of the risers have been taken off, when it drops down and returns with a slight pitch to the boiler, below the water line, Fig. 79. This is called a "wet" or "sealed" return. Sometimes the return pipes are run overhead and this is called a "dry" return. The dry return is more productive of noise in the pipes than the wet return and is not so often used. In either case one set of pipes is run from the main supply pipe in the cellar to the different radiators, and another pipe carries the condensation from the radiators to the return pipe. This requires two sets of pipes, valves, and connections, and is more expensive than the one-pipe systems which are generally used.

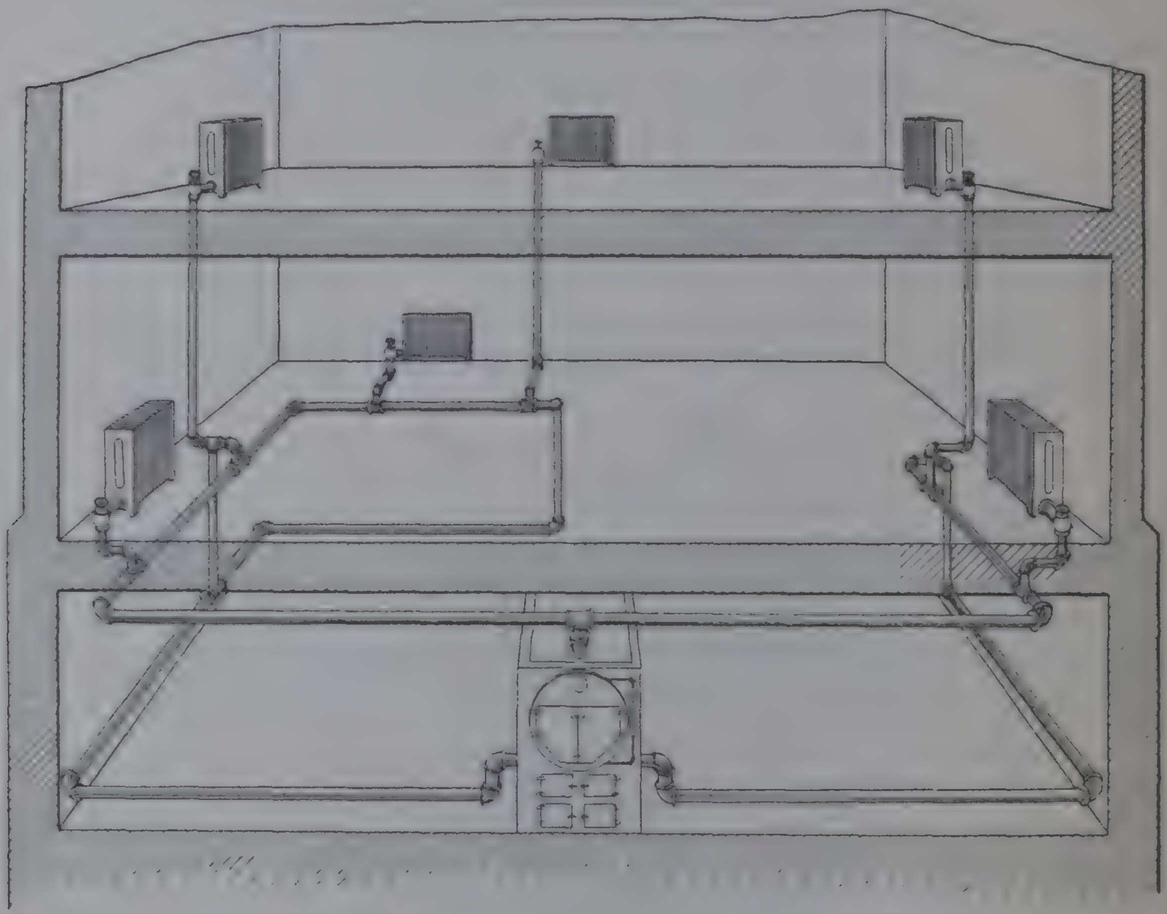


Fig. 80. One-Pipe Relief System for Steam Heating

One-Pipe Relief System. In this system the arrangement of the cellar piping is the same as in the wet return previously described, but the supply to the radiators consists of but one pipe, taken off from the main supply in the cellar; the steam flows in and the condensation drains out through this single pipe to the main, and thence through frequent drip pipes, to the return pipe, near the cellar floor, Fig. 80. If the return pipe in the cellar is run overhead, as in the dry return system, the drip pipes should be connected to the return main by a loop falling below the return, thus forming a trap and preventing the steam from flowing directly into the return.

One-Pipe Circuit System. In this system the main supply is carried to the ceiling of the cellar and there makes a complete circuit of the building at a downward pitch connecting again with the boiler below the water line, Fig. 81. From this circulation pipe, single risers are taken to the radiators, and the condensation flows back through the same pipes to the circulation pipe and is carried along with the steam and returned to the boiler. This circulation pipe should be of large size with a good pitch all the way.

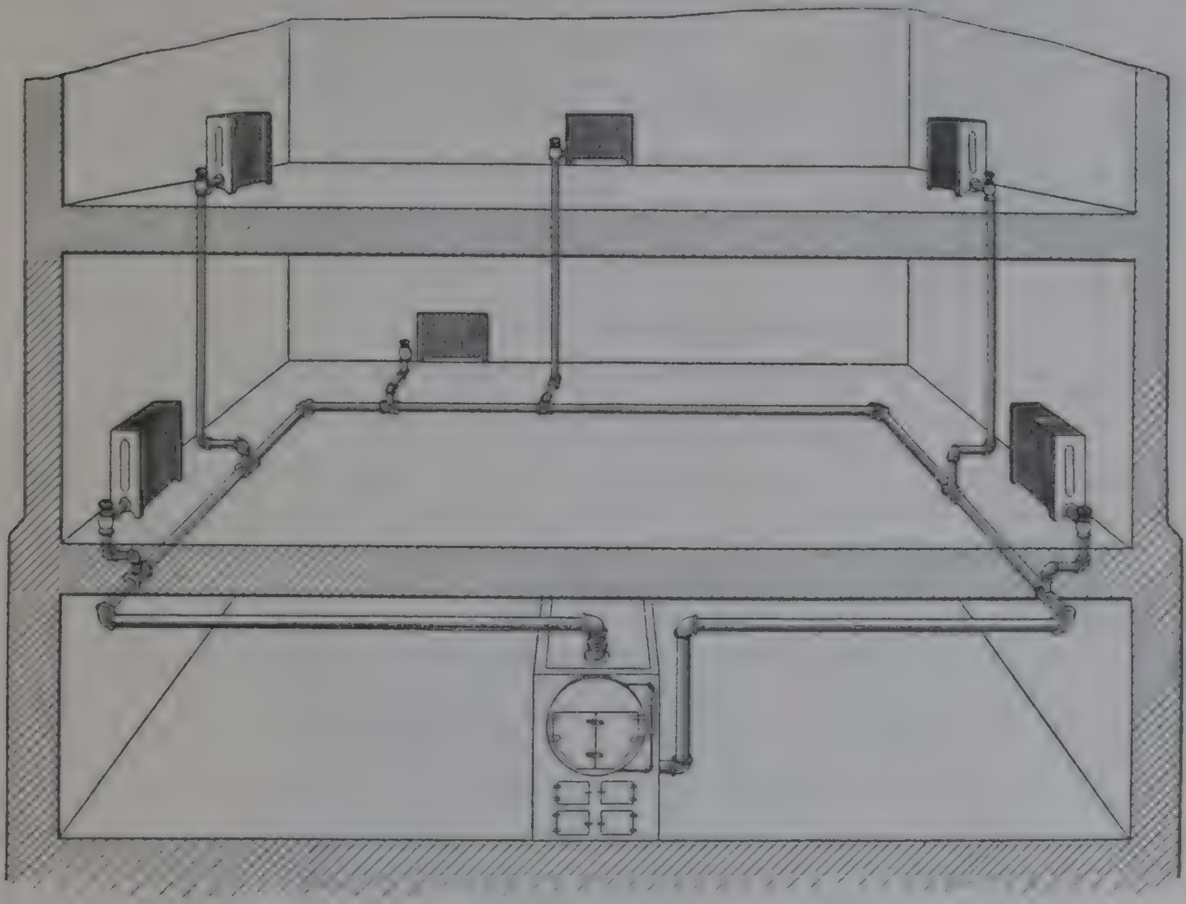


Fig. 81. One-Pipe Circuit System for Steam Heating

In all single-pipe systems the piping must be larger than in the double-pipe systems, as the steam and the returning water are flowing through the pipes in opposite directions at the same time. This may be obviated by running a single riser to the top of the building where it branches out to supply the different radiators by separate pipes run back to the basement. In this case the steam and water flow in the same direction. For large work this method is often used.

Radiators. The form of steam radiator in general use is the cast-iron radiator, Fig. 82. It consists of a series of loops connected at the bottom; the steam, entering at one end, forces the air out of the valve placed about midway of the last section. The two end sections are of the same internal pattern as the others but are cast with legs.

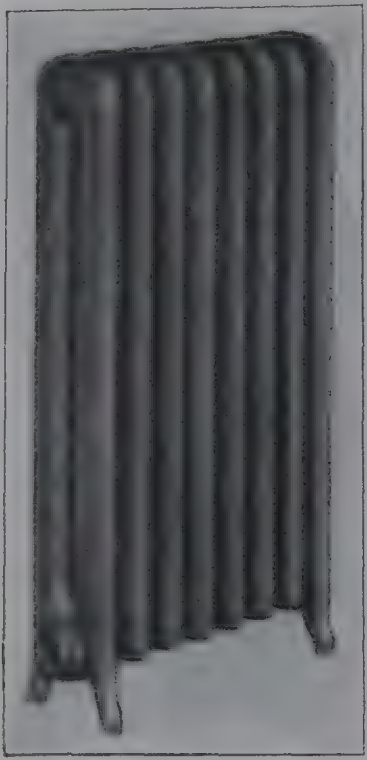


Fig. 82. Typical Cast-Iron Radiator
Courtesy of American Radiator Company, Chicago

Pipe radiators, Fig. 83, are often used and, where design is not an object, the use of circulation coils of piping may be permitted.

Valves and Connections. Careful examination should be made of the valves and pipe connections to see that they are efficient and properly applied. Many styles of valves are available, and only well-known or well-tested patterns should be allowed. Of air valves for steam radiators the simplest form is the "pet-cock", a screw valve operated by hand, Fig. 84; but there are several forms of automatic valves on the market which allow the escape

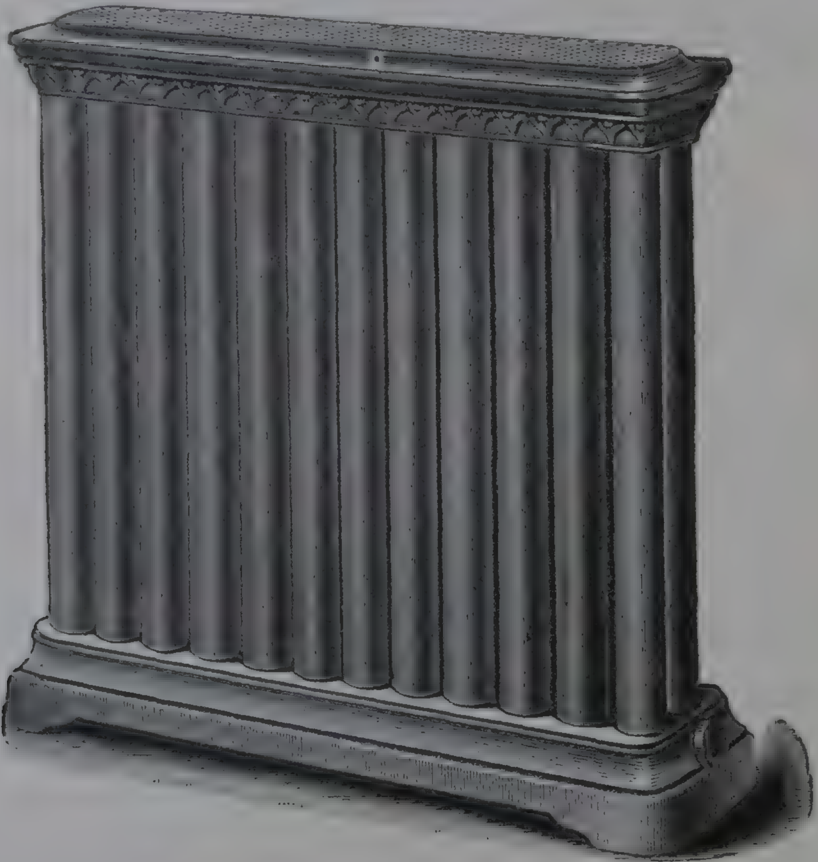


Fig. 83. Wrought-Iron Pipe Radiator

of cold air from the pipes but are instantly closed when the steam reaches them. This is accomplished by the expansion of a metal part which closes the orifice.

Boilers. Many of the ordinary types of steam boilers are used for steam heating, and in addition to these there is a cast-iron sectional boiler which is used for dwelling houses to a great extent, Fig. 85. The main thing is to select some well-known type and to see that it is carefully set, with all attachments, which will usually be described in the contracts.

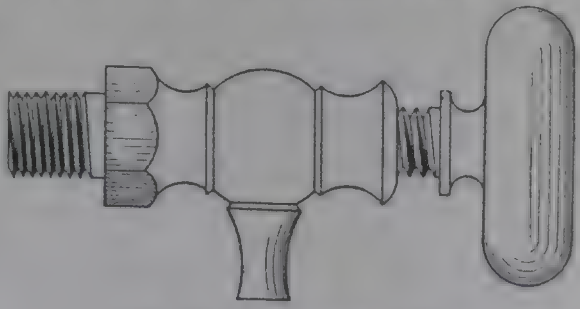


Fig. 84. Typical Air Valve

Details of Installation. This method of direct radiation lacks the advantage of the introduction of fresh air into the house, but, if care is taken to provide for that by other means we shall find the system desirable because it is economical and positive in its action. The important points to be watched are that heater pipes and radiators are amply large, and that the radiators are well placed and supplied by carefully graded pipes, tightly and neatly connected. Cellar pipes should be covered with some of the patented sectional pipe coverings, and radiators and all pipes which are exposed to view may be coated with bronze of a desired color. Where pipes pass through floors or partitions they should be protected by sleeves three-quarters of an inch larger than the pipes, and collars should be neatly placed around them at the floor and ceiling, or on each side of the partition.

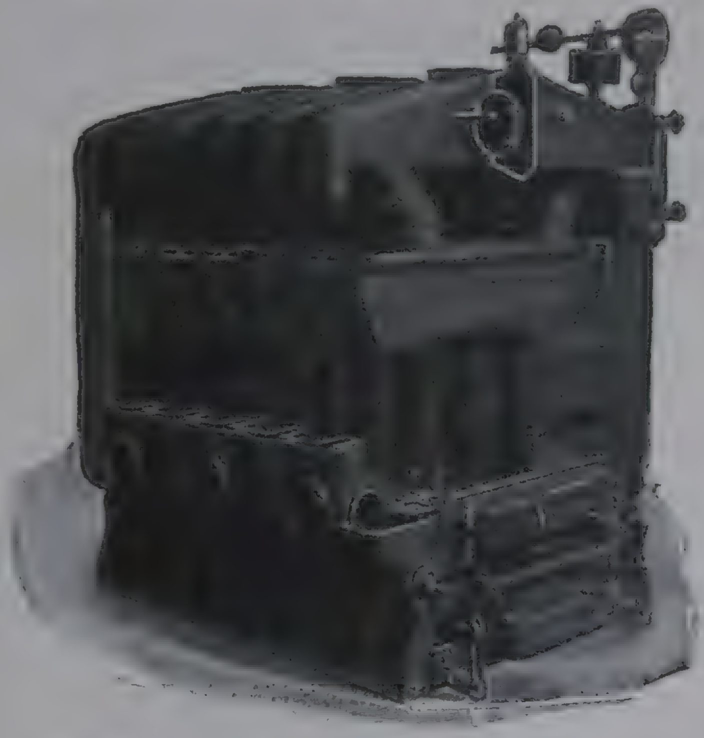


Fig. 85. Ideal Sectional 36-Inch Steam Boiler
Courtesy of American Radiator Company, Chicago

Indirect Steam Heating. Other methods of heating are by indirect steam, indirect hot water, and a combination of hot air and steam, and the same general principles will apply to these methods as to those which have been considered. The indirect application of steam or hot water is the system by which fresh air is brought to each register, after being heated by passing over a coil of steam or hot-water pipes, and while it is the most satisfactory of all means of heating, the expense of installation and maintenance is a bar to its employment for ordinary country or suburban house heating.

Vacuum Heating. A development of steam heating known as vacuum heating is a system suitable for large houses. It consists in installing in the basement of the house a vacuum pump operated automatically by town water pressure or by an electric motor. This pump, automatically controlled by the pressure in the pipes, removes the air from the pipes and radiators through automatic valves connected by a small pipe with the pump, allowing the steam to fill the system the instant it is turned on. This produces a prompt action throughout the whole system and thus effects a saving in fuel with less attention.

HOT-WATER HEATING

Another method of heating is by a similar application of direct hot-water radiation. This consists in circulating hot water through radiators placed in the rooms as in the case of direct steam heating. The hot water is conducted from the main heater in the cellar through the pipes and radiators, and the air is warmed by the direct radiation from these sources. The principle of this circulation is found in the difference in density and volume between hot and cold water. Water is at its greatest density at about 39 degrees Fahrenheit. When heated, its density decreases and its volume increases, so that as soon as the fire in the boiler is started the circulation begins; the water becomes lighter and flows up through the pipes, the radiators giving off its heat until, becoming colder and heavier, it flows back through the return pipes to the heater. This process is continuous as long as any heat is applied to the water in the boiler, the velocity of flow depending upon the difference in temperature between the supply and return, and the height of the radiators above the boiler.

Piping. The system of hot-water piping is that required for a free circulation of water from the heater to the radiators and back to the heater again. The supply pipe is taken off at the top of the heater, and main and branches are run with an incline upward, the return pipes being parallel to these and connected with the bottom of the heater. Risers are taken off the tops of the mains, and return pipes are connected with the return mains in the same manner, Fig. 86. As this system depends upon the force of gravity to keep up its circulation, an expansion tank, Fig. 87, must be provided, high enough above the highest radiator to insure free circulation, and the pipes ought to be run so that any radiator may be shut off without interfering with the general circulation. This tank should be supplied with a glass gage and an overflow to some convenient place, and an open vent pipe should be taken from the top. The connection from the heating system enters

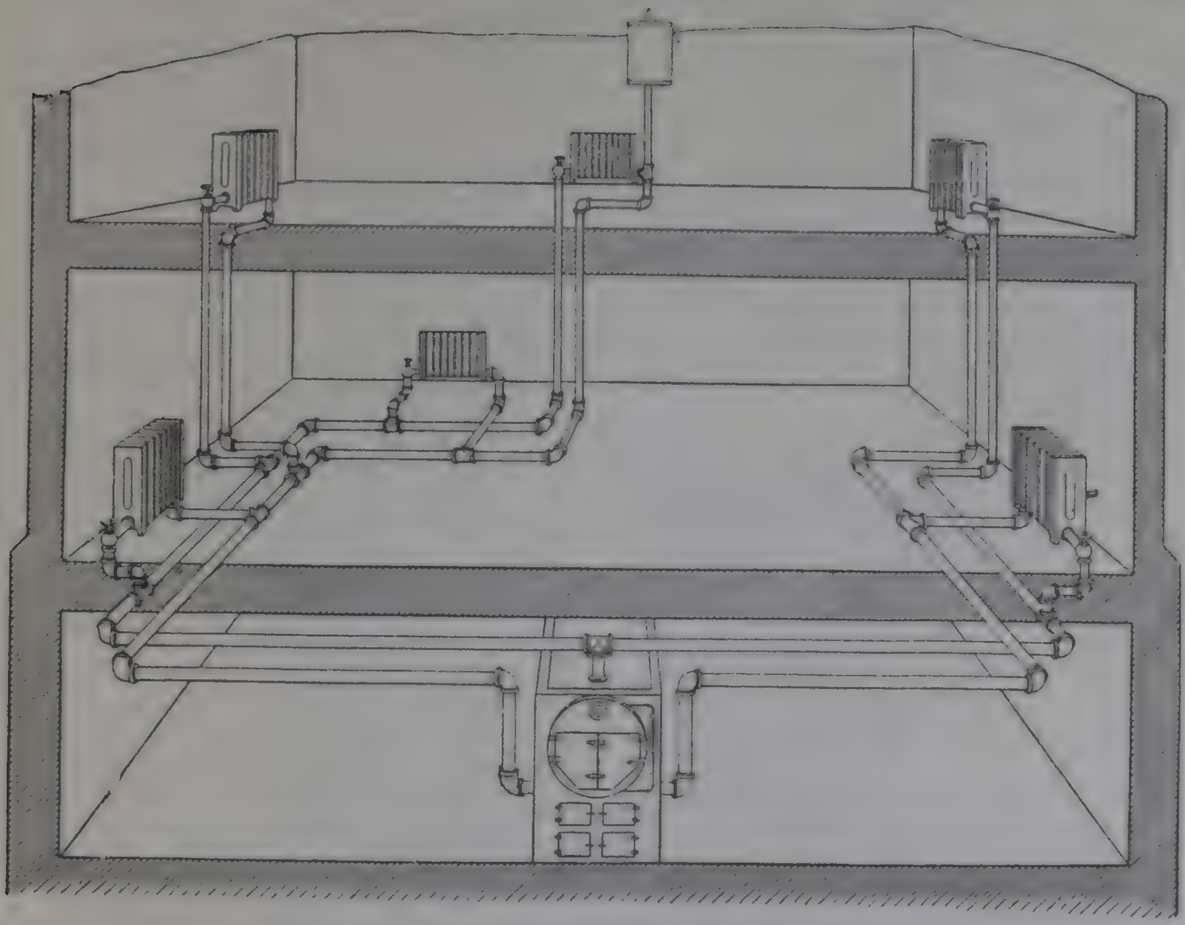


Fig. 86. Typical Piping for Hot-Water Heating

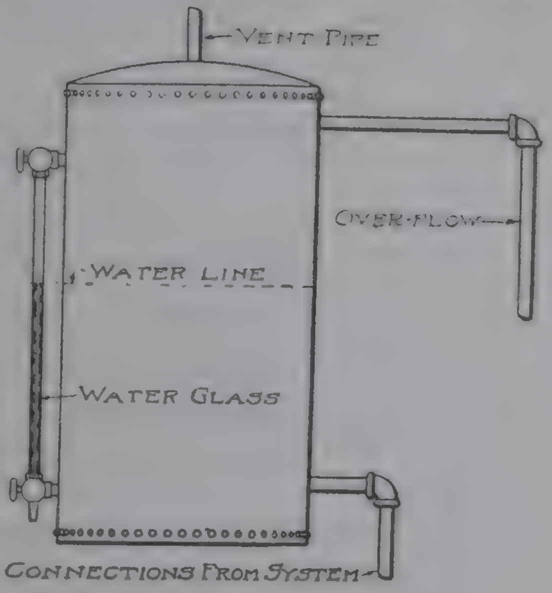


Fig. 87. Expansion Tank

at the bottom. An automatic connection should be made with the main water supply, and a connection should also be made at the heater to be used when the system is first filled, as by this means the air is driven upward and discharged through the vent on the tank.

The expansion tank should be large enough to contain a gallon of water for every forty square feet of radiation.

Radiators. Radiators for use with hot water differ from the ordinary steam radiators in having a passage at both bottom and top, Fig. 88. This is necessary in order to draw off the air which gathers at the top of each loop. These radiators may be used for steam as well as hot water and connections may be made at either top or bottom. Sometimes the piping is so arranged that, instead of running pipes to each radiator from the heater, a single riser is carried up to the expansion tank from which pipes are run to supply the drops with which the radiators are connected, Fig. 89. In this case the radiators are supplied at the top and emptied at the bottom, and as the air in this system rises at once to the expansion tank and escapes through the vent, no air valves are required on the radiators.

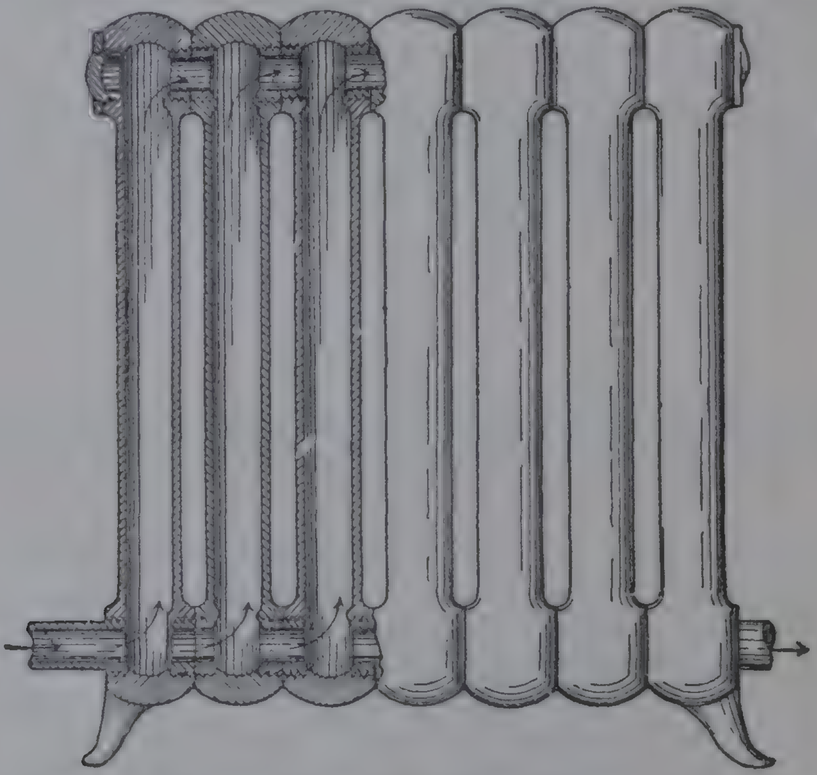


Fig. 88. Common Form of Hot-Water Radiator. Circulation Produced Wholly through Action of Gravity, Hot Water Rising to Top

Valves. Special valves are made for use with hot-water radiators, the main advantage of which is a device for quick closing, a half-turn being usually sufficient to open or close the valve. Connections with the radiators may be made at the top or bottom, the return pipe being always at the bottom. Only one valve is necessary to stop the flow of water through the radiator and this is put on the supply pipe, the return connection being made by a union elbow.

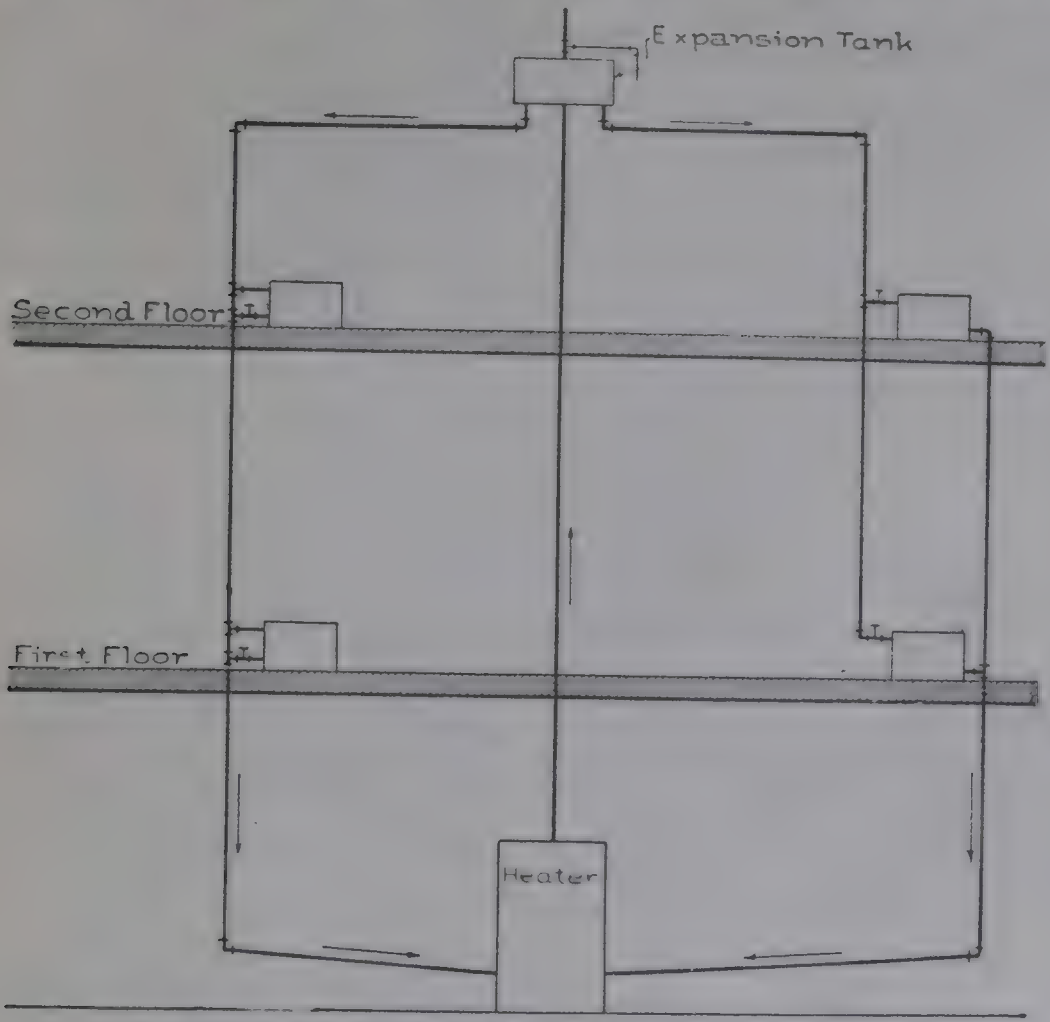


Fig. 89. Hot-Water Piping for Overhead Distribution

The ordinary petcock is generally used for an air valve, but there are several forms of automatic valves which are operated by a float that allows the air to escape when the water line is lowered but closes upon the flowing-in of the water.

Heaters. The heater differs from a steam boiler mainly in the omission of the space allowed for steam. The hot-water heater being filled with water in circulation instead of steam, it is essential that the heat should strike the surface in such a manner as to increase the natural circulation.

HEATING ACCESSORIES

Thermostats. Automatic devices for controlling the heat in a building may be applied to hot-air furnaces as well as to hot-water heaters and boilers. This device, called a thermostat, usually consists of a fixture applied to the wall of a room and connected electrically or mechanically with a motor in the basement which operates the drafts of the heater. When the air in the room reaches the desired temperature, connection is made by the expansion of some properly devised part which closes the direct draft and opens the check draft of the heater. When the temperature falls, the drafts are automatically reversed. Other types produce the same results by means of compressed air or by chemical energy, and all may be attached to a clock if action is desired at certain hours of the day or night.

Pipe Covering. Whether hot water or steam is installed, it is economy to cover the cellar pipes and the heater itself with an insulating material. For the piping, various types of covering can be obtained which are put on with bands and cement; for the boiler, a plastic covering is applied in a smooth coating which sets hard and strong. This insulation not only retains a large percentage of heat in the boiler and piping, but prevents the heating of the cellar, which is unnecessary and undesirable.

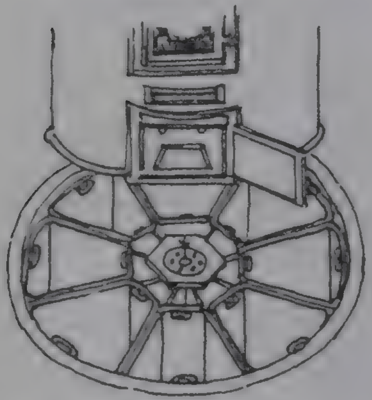


Fig. 90. Patent Ash Receiver

Ash Receivers. A useful but somewhat expensive arrangement for the care of furnace ashes is a set of underfloor ash receivers. This consists of a rotary carrier containing a number of ash cans of special radial shape, set so that one at a time they are carried under the ash box of the furnace and receive the ashes through an opening in the bottom of the box, Fig. 90. As the filled cans are revolved, they come under a removable plate in the top of the case at the level of the cellar bottom, and can then be lifted out and emptied. These receivers are arranged to contain two or three months' accumulation and so to do away with the frequent handling of the ashes.

A simple receiver consists of a single pail set beneath a cast-iron cover let into the concrete like a coal-hole cover. The ashes are swept or shoveled into the can through a small lifting cover and, to remove them a larger cover is raised and the can lifted out. This same appliance is also adapted to receiving garbage; it may be set flush with the ground in the back yard, and the small cover arranged to be lifted by a foot lever.

INSIDE FINISH

Door Frames. After the furnace or heater is set and the plastering and concreting thoroughly dry, the inside finish of the house may be put up. The door frames, which should all have been ready, will first be placed, and great care must be taken to see that they are set square and plumb. If a single rebated frame is used, Fig. 91-*a*, the superintendent must see that it is set with the rebate on the proper side of the partition. Our specifications call for double rebated frames for all inside doors as in Fig. 91-*b*, and this not only does away with the necessity for such precaution but has the merit of allowing the doors to be finished at the same height and width on both sides of the partition and also makes it possible to have the door hung on either side.

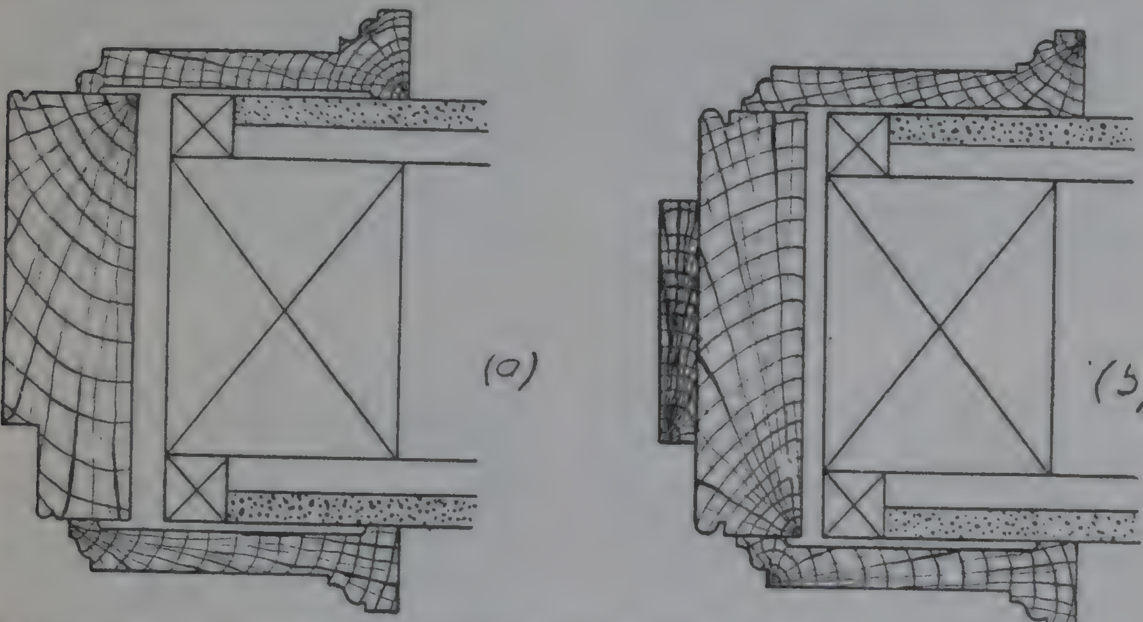


Fig. 91. Sections of Door Frames. (*a*)—Single Rebated Frame; (*b*)—Double Rebated Frame

Wall Board. It is sometimes desirable to omit the inside plastering of all or certain portions of a house and to substitute some one of the many wall boards or panel boards, Fig. 92, which have been put on the market for that purpose. These boards, built up in layers of fiber to thicknesses varying from about one-quarter inch to an inch, may be obtained in sheets of different sizes up to 4 feet by 10 or 12 feet, and form a covering quickly applied and free from the dampness, dirt, and delay of applying plaster. They do not, however, make a surface so durable or continuous as plaster, or so fire-retarding, or impervious to sound, while if applied in rather narrow widths, with a good-sized strip covering the nailings—which is important—the final cost is about the same as plaster.

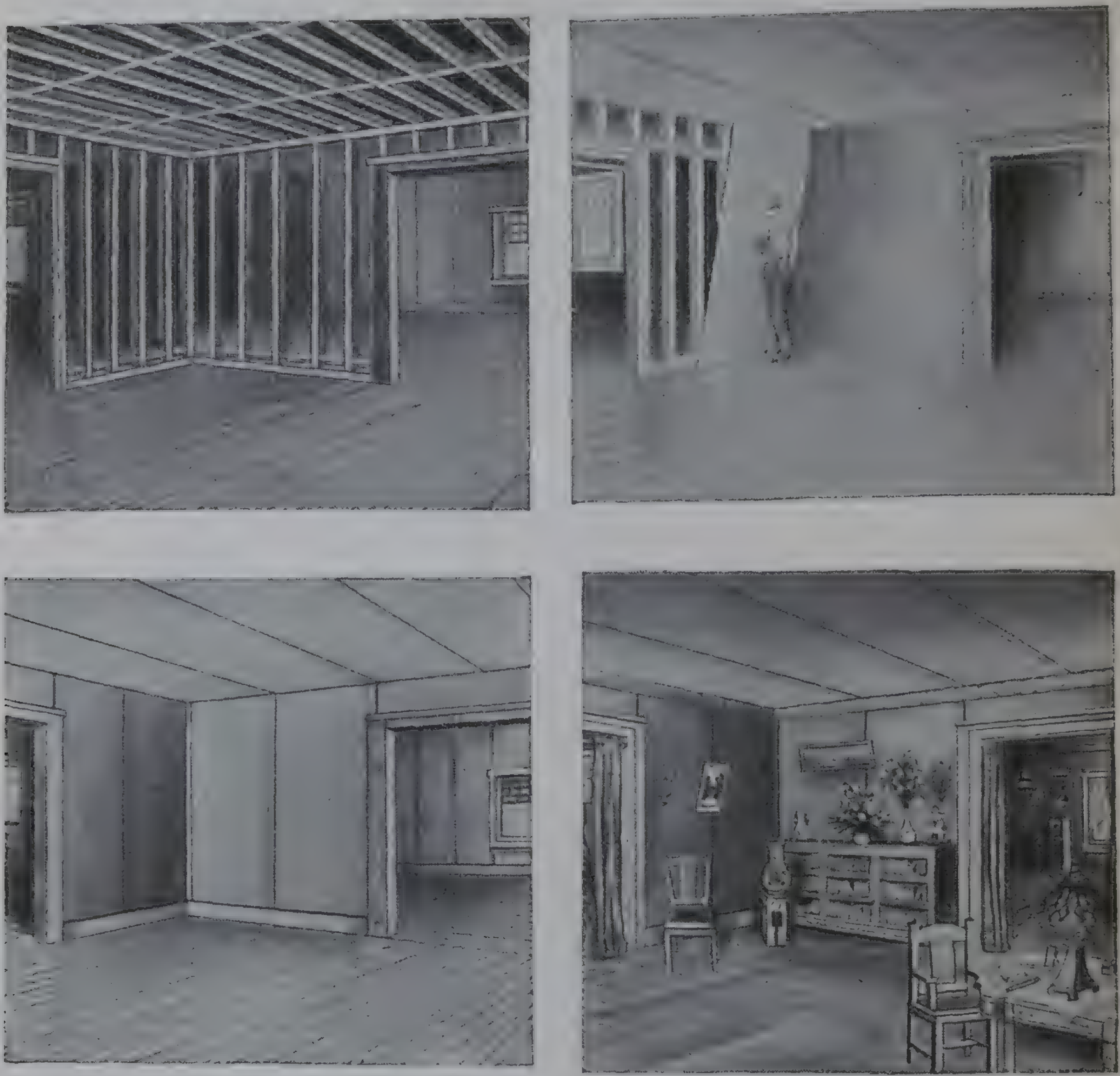


Fig. 92. Views Showing Mounting of Wall Board. Upper Left—Studding Ready for Ceilboard; Upper Right—Board Panels in Place; Lower Left—Panel Strips Mounted; Lower Right—Finished Room

Courtesy of Philip Carey Manufacturing Company, Cincinnati, Ohio

When wall board is to be used the studs should be set with reference to the divisions intended, and the directions of the manufacturers of the board, which accompany each order, should be carefully read and followed. Where the joints are to be covered, nails with a large flat head should be used; but if an extensive surface for papering or other treatment is desired, the joints should be carefully made, secured preferably with nails of the "bunghead" type, which sink into the fabric for puttying.

Beam Ceilings. The application of beams on the ceiling follows almost as a necessity the use of wall board in place of plaster. The beams may be provided for in the framing and made a part of the real construction of the house; or they may be applied to the underside of the floor construction; or they may be of lighter design, used simply as divisions of the ceiling in a decorative way. In the latter case it will simplify the construction if nailing pieces, a little less in width than the breadth of the finished beams, are inserted flush with the plaster, Fig. 93. If the finished beams are very light these pieces may be above the plastering, in which case it is possible to change or omit the final beams if later circumstances make it desirable to do so.

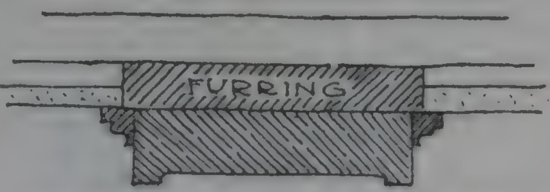


Fig. 93. Section Showing Nailing Pieces for Beam Ceilings

For light beams, employed to cover the joints in wall board applied to ceilings, there is carried in stock by many dealers in wood finish an adaptation of the combined cornice and picture molding which makes an inexpensive finish and will give a good effect if the moldings are of pleasing design. These stock moldings are also run with grooves on the top, making them available as plate rails when set down on the wall below the ceiling, Fig. 94.

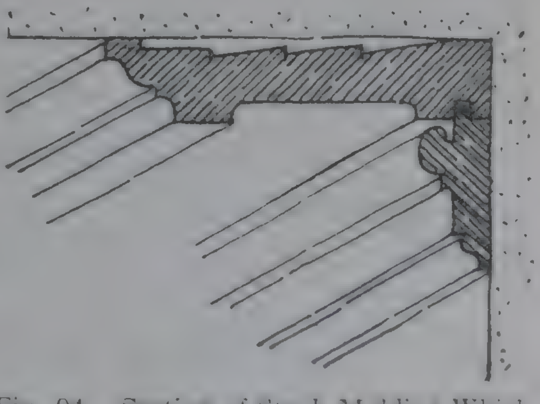


Fig. 94. Section of Stock Molding Which May Be Used for Plate Rail

Architraves. The next operation is to place the door and window architraves, called in some localities door and window "trim" although "casing" is perhaps the more common term. There are two principal methods of casing a door or window—the block casing, and the mitered casing, Fig. 95. The block casing is the simpler and less likely to be disfigured by shrinkage, as the joints are all straight across the casing, and since this will not shrink endways, the joints do not open. The mitered finish is neater in appearance but can be used only with thoroughly kiln-dried wood, as any shrinkage will cause the joints to open. Architraves of either kind are usually hollowed out on the back as shown, to allow each edge to fit closely to the frame and the plaster, and to avoid danger of displacement by possible warping or twisting of the casing or ground. Plain blocks, called plinth blocks, Fig. 96, are often put at the bottom of the door casing to the height of the base. The superintendent should watch to see that all joints are carefully made, that margins are even on all sides, and that the moldings are securely nailed. The moldings must be scraped or sandpapered, or both, to remove all traces of the milling or planing, the effect of which is to leave marks upon the wood, imperfections that appear more noticeable after varnish has been applied. No casings should be spliced; long horizontal moldings, such as bases and wainscot moldings, will, however, have to be spliced, and care should be taken to see that this is neatly done.

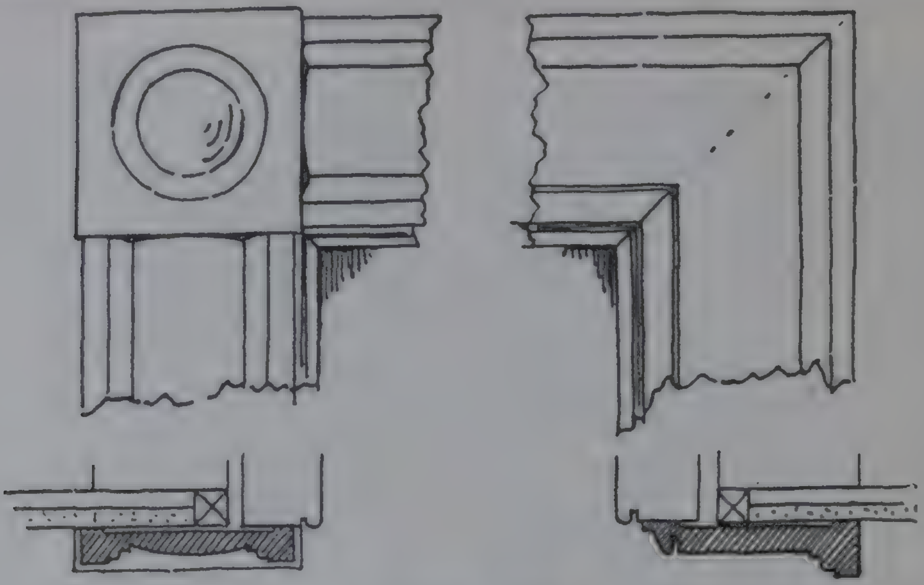


Fig. 95. Door Finish. A—Block Casing; B—Mitered Casing

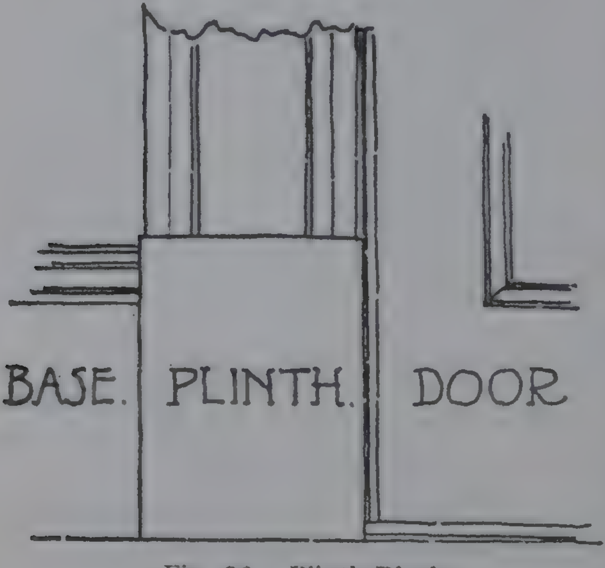


Fig. 96. Plinth Block

If the casing is to be painted, it is customary to nail the finish to the walls and frames with finish nails, well set for puttying. The nails should be driven in the quirks of the moldings as much as possible. For hardwood finish all the members that can be should be glued together at the shop, and no more nails used than are absolutely necessary. Wainscoting, if paneled, should be put together at the shop in as long lengths as possible, and painted on the back before setting, and angles and corners should be rebated together, Fig. 97.

The projections of moldings, as well as chair rails, should be studied in connection with the architraves to be sure that the two will come together in a satisfactory manner. Where a dado is used, the line of the window stools will sometimes be made the top of the cap, and in this case especial care must be taken to see that the window frames finish at the same level. Where a chair rail only is employed, it is generally set about three feet above the floor. Bases and chair rails which run between doors and windows can generally be obtained without splicing. Picture moldings if set any distance below the ceiling will need especial attention to be sure that they are level and securely nailed.

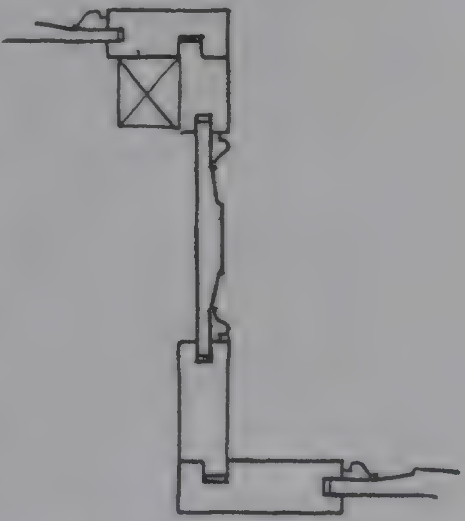


Fig. 97. Rebated Corner

Stairs. Close attention must be given the stairs to secure a satisfactory result. In the beginning the stringers must be examined to see if they correspond to the plans in the number of steps, and if ample headroom is provided where one flight of stairs comes over another. The plans will show the number but not the height of the risers, as the height can be determined only by dividing the whole distance from top to top of floors by the number of risers shown. This should have been laid out to give for ordinary stairs a rise of about 7½ inches, and the sum of the tread and rise should make for an ordinary house staircase between 17 and 17½ inches, so that with 7½ inches for the rise, the tread would be 9½ or 10 inches. Another rule is that the product of the rise and tread should be from 70 to 75 inches: that is, if the rise is 6 inches, the tread should be from 11⅔ to 12½ inches. For stairways where the space is limited winders may be inserted, Fig. 98, but where there is ample room, it is well to avoid them.

The question of headroom is an important matter and one that is not easily foreseen, so that often costly stairways, which are otherwise well conceived, are spoiled by lack of sufficient headroom. With floors of the thickness of those in ordinary dwellings, the well-room should extend over at least thirteen risers, and where one flight comes directly over another, 7½ feet in the clear, over the face of the riser, should be allowed.

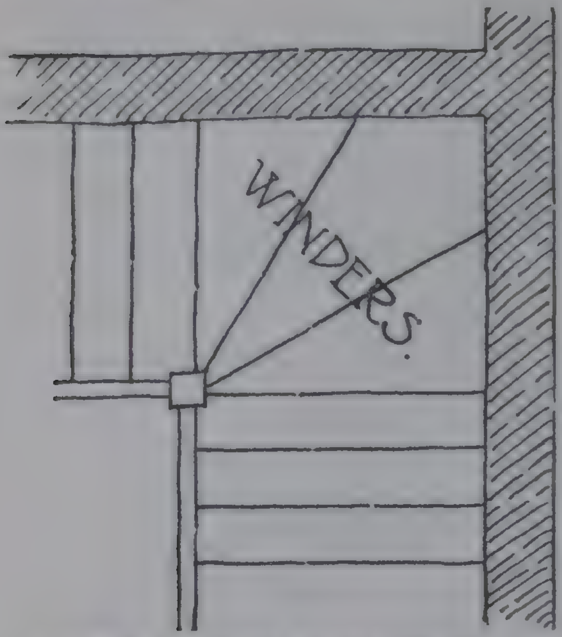


Fig. 98. Winding Stairs Showing Landing Details

In the construction of stairs methods vary somewhat. In New England it is customary to build the finished work of the stairs upon the rough stringer, piece by piece. The treads and risers are brought from the shop all fitted, and are nailed into place; the risers are first put on, grooved at the bottom to receive the tongue of the tread, and the tread grooved on the underside and fitted over a tongue in the riser, Fig. 99. A small molding is then put in the angle under the edge of the tread, and this finish is carried around the end of the step in "open-string" flights where the tread appears at the end, Fig. 100. The inside or wall edges of both tread and riser are grooved on the line of the base, the lower edge of which is scribed to the outline of the steps and cut away on the back to form a tongue, which, after the steps are all in place, is driven into the grooves, the stair nosing being cut away. This is necessary to prevent the appearance of a crack along the whole wall end of the stairs, which would otherwise invariably occur because of the shrinkage of the stairs and base; but unless carefully watched this operation is likely to be omitted, as the fitting and tonguing of the base is a difficult matter.

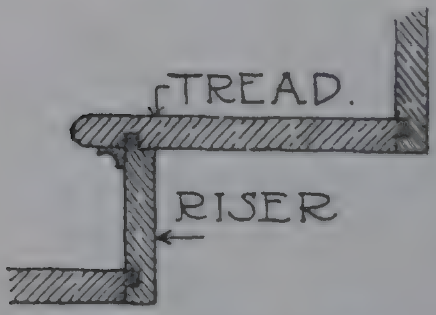


Fig. 99. Section of Stair Tread and Riser

In the English method of stair construction, the finished stairs are put together at the shop, brought bodily to the building, and fitted to the rough stringers. In this method the wall ends of the steps are grooved into the base, or wall stringer, and wedged and glued. The outer stringer, if a close or curb string, Fig. 101, is tongued and fitted into the treads and risers. This method of housing is also sometimes used when the stairs are built at the building. One objection to the English method is found where the stairs are plastered underneath, for in that case there is no good chance to fit and wedge the finished steps to the rough work; but where the underside of the stairs is paneled there is ample opportunity to wedge the work solid, which is necessary to prevent a very disagreeable squeaking. In open-string stairs, before the end nosings are put on, the treads should be dovetailed at the end for the balusters, and when these are fitted in, the nosing will make them secure. This should be done in all good work, although the general practice is merely to nail the balusters at the bottom.

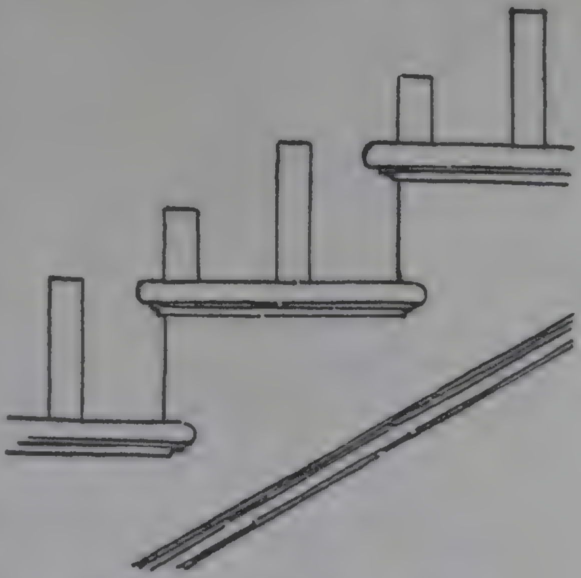


Fig. 100. "Open-String" Stairs

Against the sloping rail the balusters may be firmly nailed, but the rail must be secured to the posts by bolts, made for the purpose, which are let into the end of the rail, Fig. 102. Where the stair rail comes against the wall it is better to put a half-post than to allow the rail to run into a plate, as will be done unless the half-post is shown or specified.

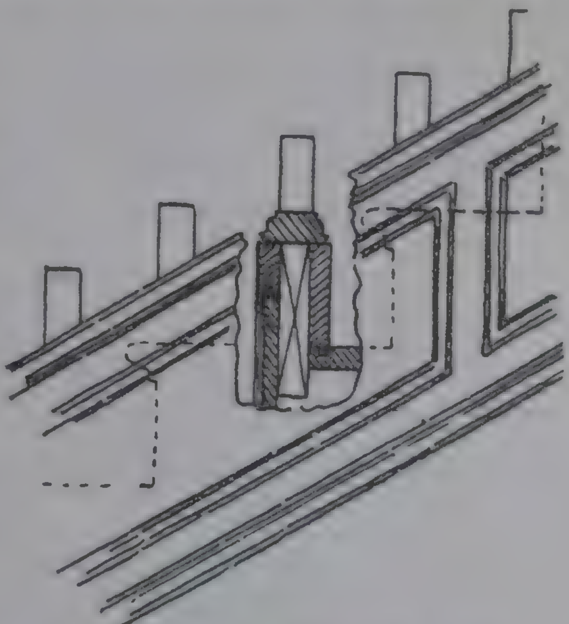


Fig. 101. "Closed-String" Stairs

Supervision. The erection of the stairs should be closely followed by the superintendent, as there is a great opportunity to slight their construction. If put together at the building, the rough stringers should be carefully verified to see that the treads are level and the risers all equal. The cutting of the stringers is a matter of great nicety, and mistakes are often made which the workmen will sometimes try to remedy by tipping the stringer, backward if it is too long, or forward if too short, *A*, Fig. 103, or by reducing or adding to the top and bottom riser *B*. This detail should be watched for and never allowed, as a slight difference in the height or level of the steps is a source of danger. If the English method is used, especial care must be taken to see that the finished work is securely blocked and wedged.

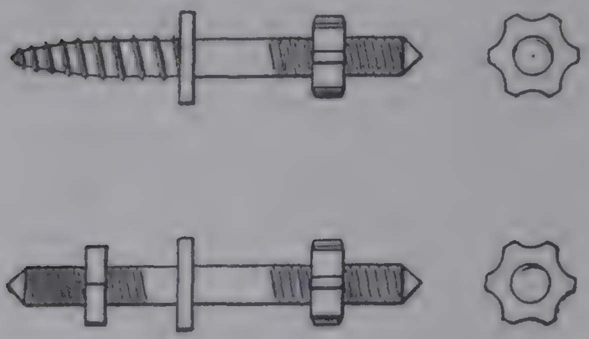


Fig. 102. Rail Bolts

Windows. As a part of the finishing of the inside of the house comes the adjustment of the sashes and doors. The sashes are held in place by stop beads, which are strips of wood usually one-half inch in thickness and of varying widths, according to the thickness of the sashes and of the walls, Fig. 104. These stop beads should always be secured by screws, as it will sometimes be necessary to remove them to adjust or replace the sashes. Special screws are sold for the purpose, which have a washer with a horizontal slot, that permits, by simply loosening the screws, the slight adjustment made necessary by the swelling or shrinking of the sashes. Before applying the stops the sashes must be carefully fitted and balanced, and as they will vary somewhat in weight, the matter of a perfect balance requires close attention. The superintendent should see that each sash is so balanced that there will be no great effort needed to raise or lower it, and no danger of its banging by reason of too much or too little weight.

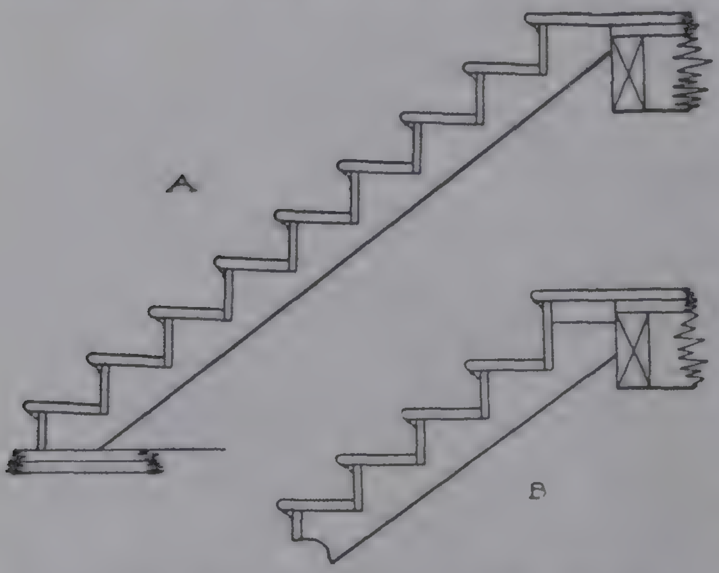


Fig. 103. Faulty Construction in Stair Stringers

Hardware. The superintendent must also closely examine the hardware to make sure that it is as specified and is carefully put on. Sash fasts are often badly set, and each one must be tried to see that it works properly and easily. Pulleys should be carefully inspected to see that they are as specified. These will probably be already set in the window frames when they are received, and unless the contractor has paid especial attention to them they are very likely to be of an inferior order. The difference between a *plated bronzed* face and the *solid bronze metal* face called for by our specifications is often overlooked, and the bearings will be inferior if not carefully examined. A steel axle pulley may be used for ordinary work, but for better service a turned or milled axle is preferable.

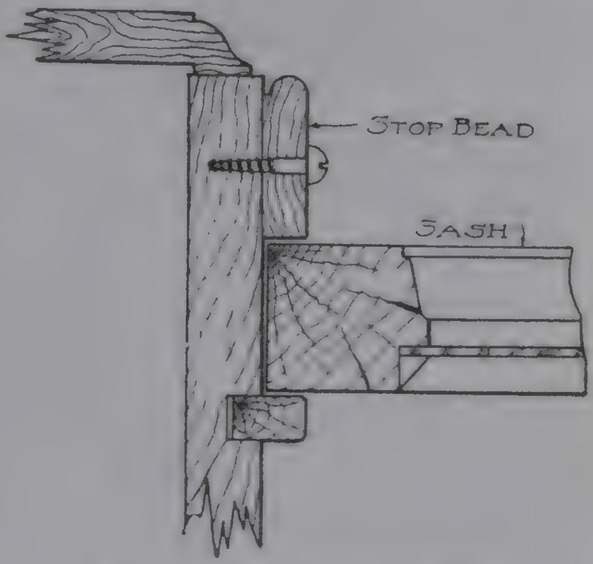


Fig. 104. Window Stop Bead

Cords, chains, and metallic ribbons are used for hanging the sashes, but for windows of ordinary sizes a good braided cord is perhaps to be preferred, this depending upon local custom. The size and particular brand of cord should be specified and care taken to see that this is furnished. The leading manufacturers have adopted a copyrighted device of a spot or name which appears at short intervals upon their cord and which, if noted, will prevent the substitution of any other.

For large sashes with no vertical bar, such as are shown in the main rooms of our house, sash lifts should be used. These are metal fixtures applied to the lower or side rims of the sashes to afford a hold for the fingers when raising the sash. When windows are as wide as those shown and have no vertical bar, the habit of starting to raise the sash by lifting on the middle rail will result in loosening the putty and springing up the rail, and for that reason lifts are necessary. They may be of the ordinary hook shape, or they may be a metal slot let into the lower sash, Fig. 105.

Mullioned Windows and Casements. The present tendency to group the windows of a house demands special hardware for the mullioned windows and also for casements. The design of the mullions often requires that the divisions between the windows should be as small as possible. Where this prevents the use of the ordinary weights for sliding sashes, spring pulleys may be installed either in the side jambs, or overhead if the vertical divisions are very small.

Casement windows present a difficulty peculiar to themselves. The long casements which give access to outside balconies or verandas are not usually difficult to manage as they are, in effect, doors, and can usually be treated in a manner similar to the doors. The main difference is that the windows are often in pairs, and, whether double or single, the vertical stiles are generally made much smaller than for wooden doors; care must be taken, therefore, to select hardware small enough to fit the narrow stiles.

Short casement windows, used in the place of the ordinary sliding sashes, introduce a problem which requires special treatment. The owner will usually have definite ideas as to whether the casements should open out or in, and in either case complications at once arise which demand special consideration and recommendation by the architect. If the sashes are to open out, the ordinary outside blinds and fittings cannot be used. Then, too, the screens must be put inside of the sashes, and, if the fastenings are of the usual kind this means that the screens must be hinged and open in, to the detriment of draperies and curtains. If, on the other hand, the sashes are to open in, the sashes themselves will interfere with the draperies and will be, besides, harder to keep tight than sashes opening outward; the screens, moreover, if placed outside the sash, will interfere with operating the blinds or shutters in the usual way.

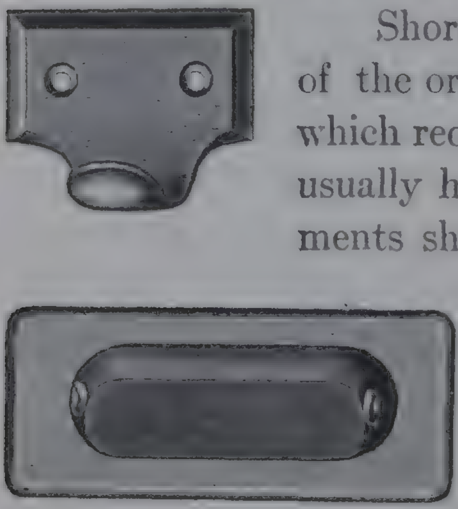


Fig. 105. Sash Lifts
Courtesy of P. & F. Corbin Company, New Britain, Connecticut

To overcome these difficulties, special adjusters have been devised which permit the opening and closing of either outside blinds or sashes without opening the intervening screens or sashes. The least conspicuous of these consists of a pivoted arm to be set in the space between the sash and the screen, Fig. 106, the pivot extending down through the sill and connecting with a rod or arm brought through the sill to the inside, where a sideways movement opens or closes the sash or blind. Another pattern is set on the top of the sill and works entirely in sight, the lower rail of the screen being made wide enough so that it can be cut out to fit over the pivot, Fig. 107.

Doors. The last of the interior fittings to be installed are usually the doors. They are of two classes—stock doors and doors made to order.

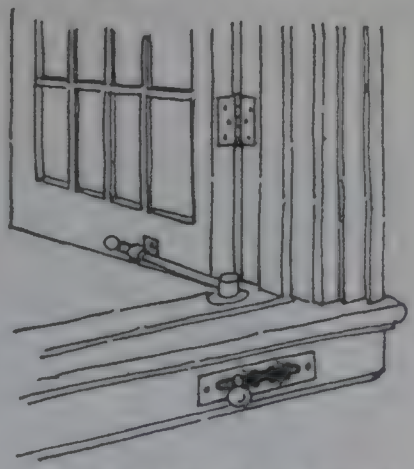


Fig. 106. Device for Opening Casement Windows

Stock Doors. These are made in certain regular sizes, are generally of pine, whitewood, or cypress, and may be obtained at all times from the dealers. They are of three grades, A, B, and C, the first of which may be used for the cheaper portions of good houses; but, because they have been stored for a greater or less time, stock doors are generally not thoroughly dry and will shrink and twist when subjected to furnace heat. Stock doors of the second and third qualities are very inferior articles and should be used only for the poorest kind of work.

Doors of excellent quality and design are now made with built-up cores, and specially sawed veneers producing large plain panels or a wholly plain surface, Fig. 108. These doors are held "ready to ship" in a great variety of styles in birch or oak, and are manufactured to order in any other wood. They also come with a full length mirror on one side such as is often used in bedrooms or dressing-rooms. If these are installed, it is well to place them where they will be in least danger of breakage when not in use, and also where there will be room to stand far enough away from the glass to allow a good view.

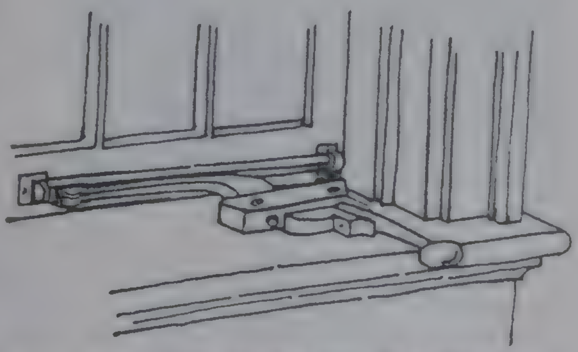


Fig. 107. Device for Opening Casement Windows

Custom-Made Doors. The doors of the principal rooms should be built to order. If of pine or whitewood they may be made solid but must be of kiln-dried stock and kept perfectly dry. The tenons should be made, as specified, with haunches, Fig. 109, and the panels put in without bradding or gluing, so that they may swell and shrink without cracking. Hardwood doors are veneered upon a core of well-seasoned pine and should be examined upon delivery to see that this is done and that the veneers are of the proper thickness. The veneers should be $\frac{1}{4}$ inch on the face and at least $\frac{3}{4}$ inch on the edges, to allow for fitting. If the panels are of great width they also should be veneered, with the grain of the core running at right angles to the grain of the veneer. Doors which are to show hardwood on one side and a painted finish on the other should be veneered on both sides to prevent warping, which may occur if one side only is veneered. In the design and selection of doors care must be taken that the panels are so divided that the lock in its normal position will not cut off the tenon of the rail but will come opposite a panel, Fig. 110. The rails of a door are always tenoned into the outside stiles, and if there is a middle stile, that is tenoned into the rails, Fig. 111, so that the tenon at *A* is an important factor in the strength of the door and should not be weakened or destroyed by being cut for the lock.

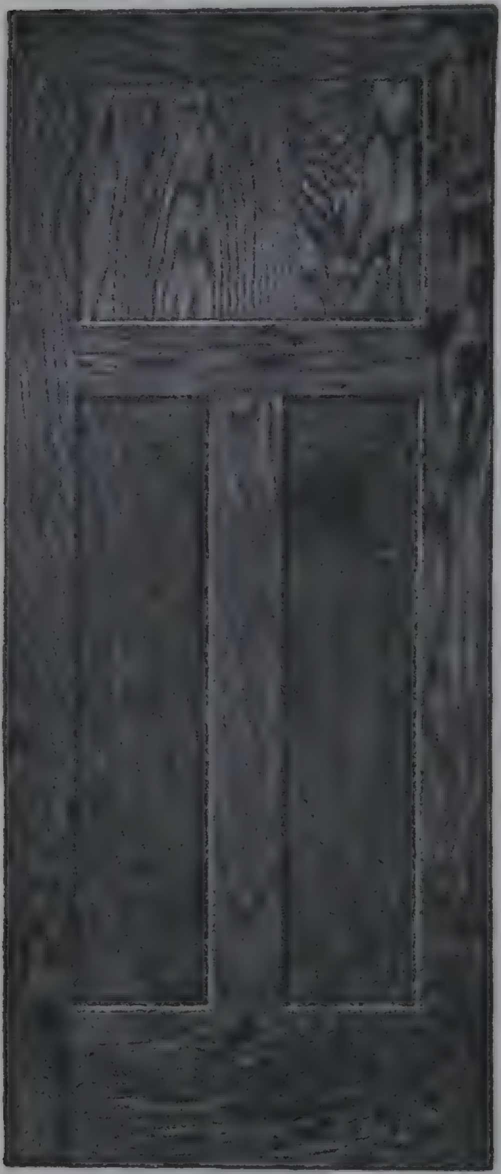


Fig. 108 Stock Oak Door
Courtesy of Morgan Sash & Door Company, Chicago

Hardware for Doors. The hanging and fitting of the doors is a matter of great nicety and should be intrusted only to careful workmen. The hardware for an ordinary door will consist of the hinges, or butts, the lock, knobs, and escutcheon plates. Double doors will need in addition bolts for the standing part. Sliding doors will be hung on a hanger, and the fittings must necessarily be flush to allow the door to slide into the wall. The specification of hardware for doors is often made a matter of an allowance—either a certain price is fixed per door, or a sum is named to cover all the hardware of the doors, the selection being left to the architect or owner. The latter method has been adopted for our house and the architect's knowledge becomes necessary in guiding the owner to a proper choice at the dealer's rather than in inspecting the hardware at the building.

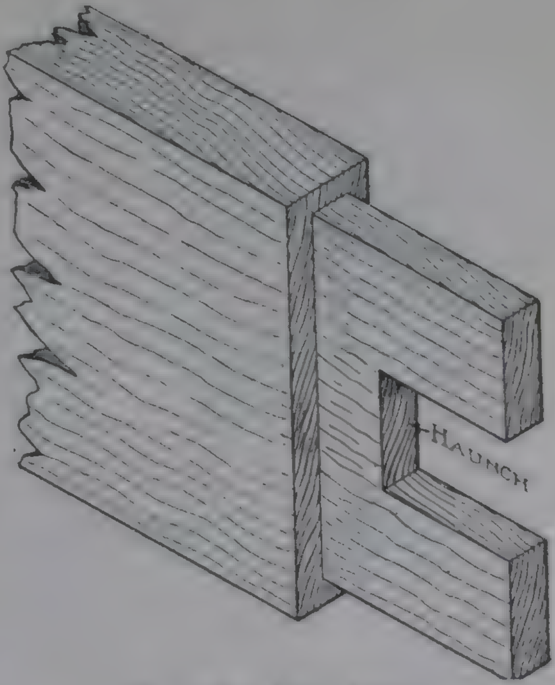


Fig. 109. Door Tenon

Hinges. In the selection of hinges the choice of material will be principally between solid bronze or brass, and plated, japanned, or lacquered iron or steel. If of solid metal the best quality only should be used with steel washers and bearings, as the soft metal will otherwise wear out from the swinging of the door. Modern door hinges are invariably made in parts, to allow the door to be removed without unscrewing the hinge, and this is accomplished by two methods, the *loose-joint butt* and the *loose-pin butt*. The former consists of a hinge made in two parts, Fig. 112, the section containing the pin being screwed to the door frame and the other section screwed to the door; this permits the door with its half of the hinge to be

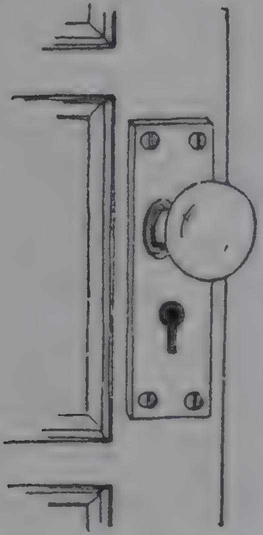


Fig. 110. Proper Location for Latch and Lock

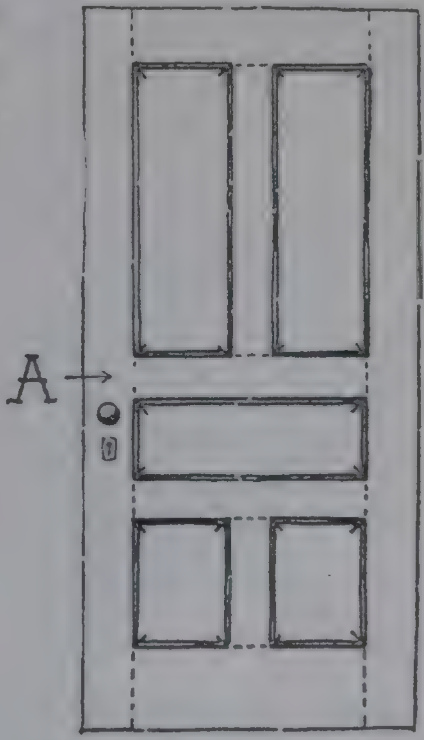


Fig. 111. Diagram of Door Showing Location of Lock to Avoid Weakening Door Tenon

lifted off if desired. With the loose-pin butt, Fig. 113, the door is removed by drawing out the pin and slipping the hinges apart. Loose-pin butts are coming into more general use than formerly and possess some advantages. In the first place, the bearing surfaces are multiplied, and since the pin is separate from the leaves, it can be made of harder metal. Again, as either leaf can be fastened to the door or jamb, the same hinge can be used for a right-hand or a left-hand door, and the fact that the pin can be withdrawn makes it possible to open the door even when locked. This may sometimes be a disadvantage, however, and that fact should be borne in mind in planning doors which open out of a room that must be made secure.

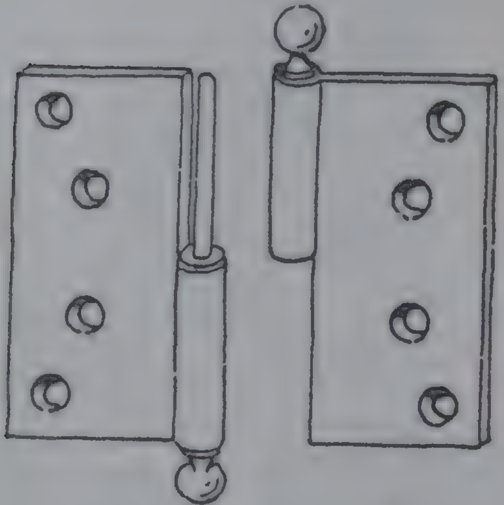


Fig. 112. Loose-Joint Butt

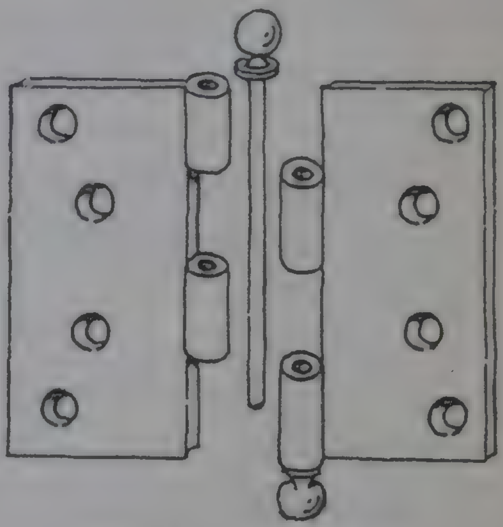


Fig. 113. Loose-Pin Butt

Locks. The variety of door locks is so great that mention can be made of only some of the distinguishing features. According to their construction, locks are generally either *tumbler locks* or *cylinder locks*, and according to their position on the door, they are either *rim locks* or *mortise locks.* Tumbler locks are the ordinary kind of lock operated by a long key, Fig. 114, and depend upon tumblers or levers which are raised by the key to an exact position before the bolt can be thrown. Cylinder locks consist of two cylinders, a small one rotating inside of a larger one and turning only when a key of the proper shape and size is inserted, Fig. 115. Cylinder locks are not so easy to pick as tumbler locks, and there is less danger of an accidental exchange of keys, so that they are recommended for outside doors or wherever special security is desired.

Rim and mortise locks differ only in the form of the case, rim locks being made to screw on the face of the door, Fig. 116, and mortise locks being let into the edge of the door, Figs. 114 and 115, the inside construction of both being the same. For ordinary house use, a three-lever lock with brass or bronze face is good enough, but a cylinder lock may be used to advantage for the outside doors. The latch and lock will generally be found in combination and may be used with a long plate covering both knob and keyhole, or with a separate treatment of the keyhole by means of an escutcheon, Fig. 117.

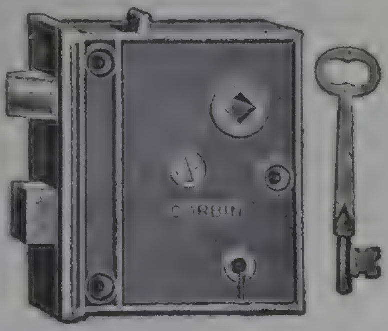


Fig. 114. Typical Tumbler Lock

Courtesy of P. & F. Corbin Company, New Britain, Connecticut

Knobs. Whatever treatment of escutcheon plate is adopted, the knobs and spindle will be the same and may be selected from a variety of materials and shapes. The cheapest knobs are of composition and are commonly called mineral, jet, or porcelain knobs. Wood finished in natural color is used to some extent, and glass as well. All of these are sold with bronze shanks and escutcheons. A better class of knob, and perhaps the most satisfactory of any, is one of brass or bronze, either wrought or cast and in a wide variety of shapes and finish.

Bolts. Of greater protection than locks on a door are bolts, which, being operated from one side only, are secure against picking. The simplest and least noticeable of these are the mortise bolts, which set in a hole bored in the edge of the door and are operated by a knob or key on the face. Chain bolts are a protection in localities infested by tramps or other intruders. These bolts consist of a strong chain which is secured to the frame and hooks into a slotted plate on the door. The door can be opened only to the length of the chain, and not until it is closed can the chain be again dislodged, Fig. 118.

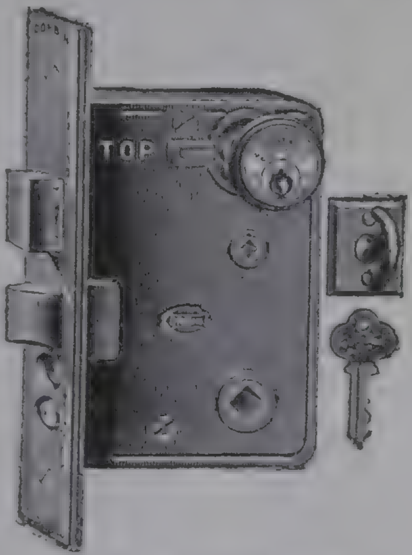


Fig. 115. Typical Cylinder Lock

Miscellaneous. The many small fittings, such as coat hooks, drawer handles, cupboard latches, and the like, should be selected for strength and utility rather than for effect, and are the most satisfactory in plain bronze or brass. Those of good manufacture and material can be obtained at moderate prices.

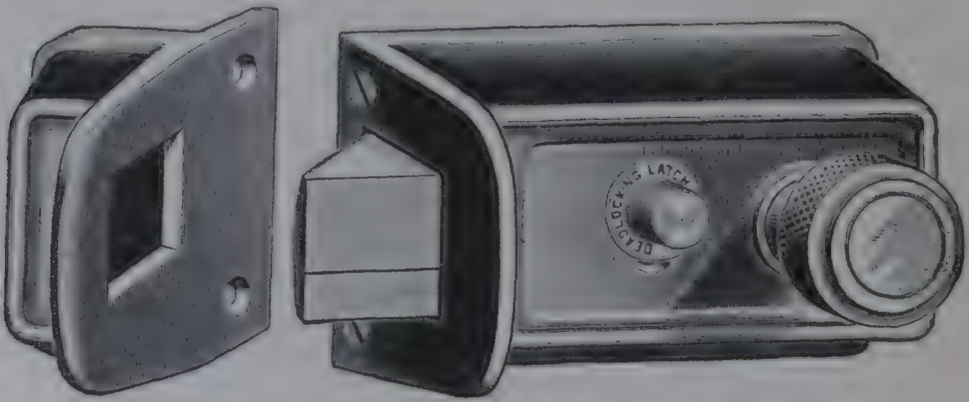


Fig. 116. Typical Rim Night Latch
Courtesy of Sargent & Company, New Haven, Connecticut

Supervision. The inspection of hardware is an important matter, whether it is furnished by the owner or the builder, as any changes made after fixtures are once applied are certain to produce defects of some kind. What purports to be bronze may be some baser metal, skilfully bronzed or lacquered on the face. This may be detected by scraping the back with a knife or file. The faces of locks or bolts may be plated instead of being solid. Knobs may be poorly fastened to the shank, and may lack the washers necessary to prevent rattling; and hinges may be furnished with no washers so that they will soon wear and creak.

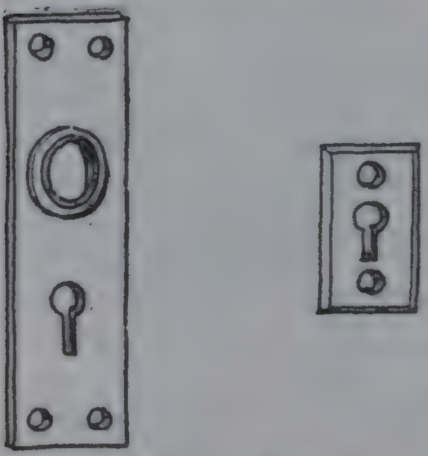


Fig. 117. Plate and Escutcheon

In the application of the hardware, also, it is necessary to keep a sharp watch. Even in so simple a matter as putting on door hinges there is a right and a wrong way, for if the butts are not directly over each other the door when opened will swing either backward or forward. Mortises must be accurately cut so that the locks will be neither loose nor so tight that they cannot be removed if required. Roses or escutcheon plates must be put exactly opposite each other or else the spindle will bind in the lock. Knobs must be carefully adjusted by means of washers so that they will not slip back and forth. Striking plates for latches, Fig. 119, must be carefully centered and adjusted. While all hardware is usually packed with screws finished to match, the screws are often too small and their efficiency destroyed by being driven in with a hammer by careless workmen. This should never be allowed, but every screw should be set with a screw driver. Good-sized screws are especially important in door hinges, and the hinges themselves must be big enough to allow the door to swing entirely back. The greatest vigilance is necessary to make sure that the hardware is free from defects of selection or application, and nothing will reflect more credit upon the superintendent than a good job in this part of the work.

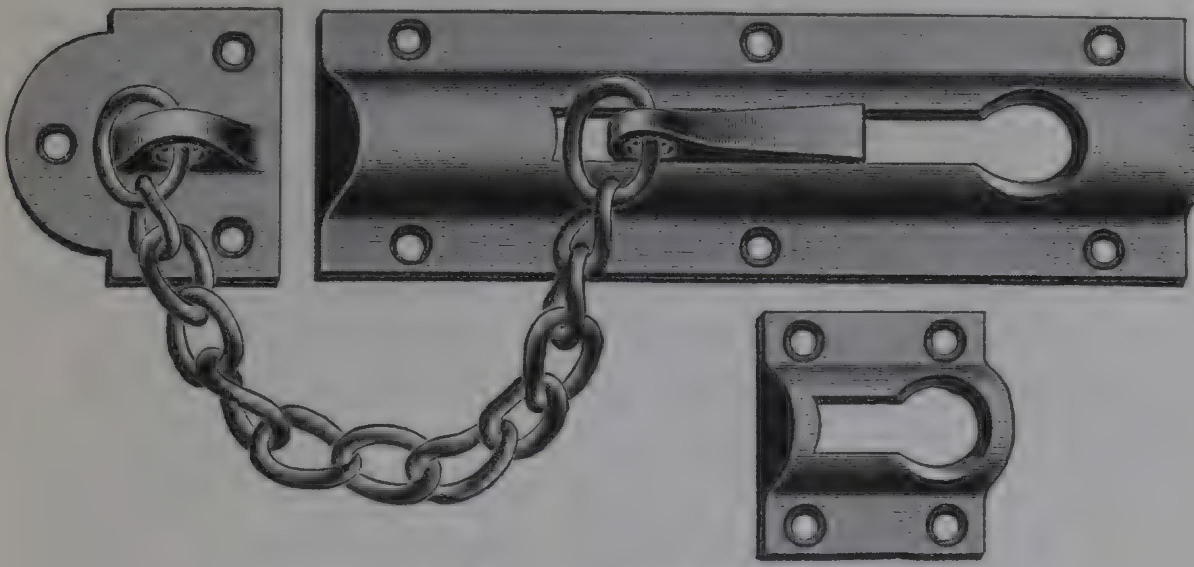


Fig. 118. Chain Bolt
Courtesy of P. & F. Corbin Company, New Britain, Connecticut

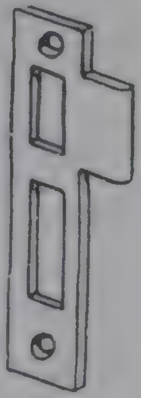


Fig. 119. Striker

Screens. It is well at this time, if the matter has not already come up, to see if the construction of the fly screens is far enough advanced so that they can be installed as soon as the outside painting is finished. The screens may have a wood or a metal frame. In either case they should be made so that the wire can be replaced if necessary. Copper wire, or an alloy of copper which will not rust, makes the most durable screen, but galvanized or "pearl" wire is good enough for ordinary use. This may be painted black if the look of the glistening wire is objectionable, but copper or bronze wire soon tarnishes and darkens in color.

Screens for the main part of the house are usually made to cover one-half of the window only, but the guides or runners should be full length so that the screen may be used at either the top or bottom half of the window. For the service portion of the house it is well to apply an outside screen of the full size of the opening, so that the windows may be opened top or bottom without stopping to see if the screen is in place. Screen-doors should be provided for all outside doors and French windows, and attention must be given to them in time to make certain that they correspond in the main divisions, to the solid door or window at which they are to be placed. It will also be necessary to designate the style and finish of the door hardware, so that the screen hardware may correspond.

Floors. When the inside finish has been put up, the rough under floors should be gone over, all holes and broken boards repaired, and the floors cleaned off, ready to receive the finished floors. The laying of these, if they are of hardwood, is generally let to a special floor-layer, but sometimes it is done by the carpenter. For the carpeted rooms a good quality of square-edged spruce flooring not over 4 inches wide will be used. It is best to have the boards laid in one length, but if this cannot be done, the range of joints should be broken as often as possible. If the boards are of the same width they can be broken every course, but when the boards are of unequal width there will be a straight joint through three or four boards. The nails of a square-edged floor are driven through the face of the board and sunk with a nail set, to be puttied or not, according to whether the floor is to be finished or left plain. A line should be drawn where nails are to be driven, over the center of the joist below.

Floor Paper. Between the upper and under floors it is well to lay a deadening layer of paper. This may be asbestos felt, which is valuable on account of its fire-resisting qualities, or a common floor paper. It should be put down in two thicknesses.

Matching. Where finished hardwood floors are used, it is necessary to have the floor boards matched so that the nails may be concealed. In blind nailing, as this is called, the board is nailed only on one edge, and the matching is depended upon to hold down the other edge. For this reason the floor should be laid of narrow strips each with a tongue and groove, the grooved edge being forced over the tongue of the preceding strip and the tongue in turn nailed diagonally, Fig. 120. The boards for under floors, where a handsome upper floor is desired, should be narrow, not over 4 inches wide, for each board in shrinking will compress as many strips of the upper floor as may be upon it, leaving a wide crack over the crack in the under floor. This defect may be overcome by laying the under floor diagonally or at right angles to the upper floor.

Stock. Of flooring stock in general, quartered oak makes the best floor for appearance and wearing quality, but birch and maple are used to a great extent, and rift hard pine makes a good floor for ordinary use. Quartered oak is sawed from the trees as nearly as possible on radial lines, Fig. 121, and shows an even, straight grain with irregular streaks, upon a ground of fine parallel lines. In rift hard pine the parallel grain is more pronounced and of a coarse growth. All flooring must be kiln-dried and laid hot from the kiln, or as soon as possible after delivery. To obtain a perfectly even surface the floor must be "traversed", that is, planed across the grain.

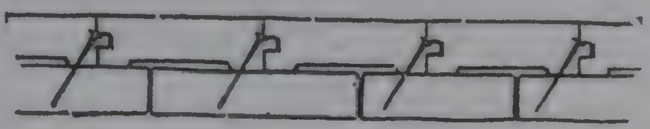


Fig. 120. Blind Nailing for Matched Flooring

A thin floor which is only $\frac{5}{16}$ inch thick is used to good advantage over an under floor which is in good condition. It is skilfully handled by a professional floor-layer, and is often laid to a more or less elaborate pattern. Being too thin to match, these floors are nailed through, and the nail holes so cleverly puttied as to be almost invisible.

While the floors and finish are being installed it is a good plan to have artificial heat in the building, which should be maintained until occupancy. This is especially necessary in the case of parquetry floors.

Composition and Linoleum. For the service portion of the house a floor may be laid of one of the many composition or monolithic floorings on the market. These are made from various formulas, having a base of cement, asphalt, or other plastic medium, and a wearing of cork, sand, or various substances imbedded or applied. When this kind of floor is used, it is customary to carry the floor, by means of a sanitary cove, up the side wall to form the base- or mopboard. Heavy linoleum cemented to the wood, concrete, or other surface of the floor, makes an excellent finish which is easily kept clean and in sanitary condition.

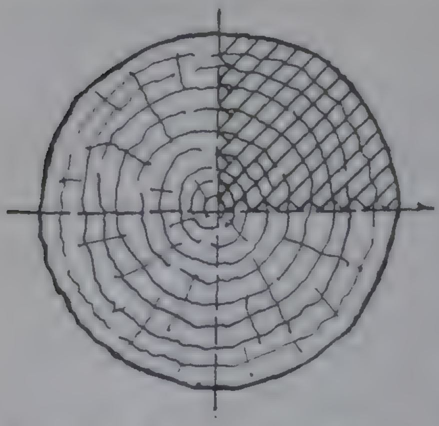


Fig. 121. Typical Log Section Showing Method of Quarter-Sawing

Final Details of Finishing. A number of different points connected with the finishing arise as the house nears completion, and the superintendent will do well to inspect the work constantly to see that every detail is being carried out as it should be. Thresholds should be carefully fitted, and cornices, chair rails, and picture moldings must run level and true. Sashes must be tried to be sure that they are accurately balanced and hung. Every sash fast, lock, and knob must be examined, and all drawers, slides, and other movable fixtures tested and left in good working order.

PAINTING

EXTERIOR PAINTING AND STAINING

Priming Coat. The outside finish of the house should receive as soon as put up the first or priming coat of paint. This is usually done more or less by piecemeal as the different parts of the house are completed, and requires the superintendent's attention mainly to see that the materials are pure and that the surfaces are well covered. This first coat should contain a large proportion of white lead, which adheres to the new wood far better than any other substance and retains the second coat well. Pure linseed oil should be used, but unless care is taken this is likely to be adulterated with fish oil, which dries slowly and never hardens like pure oil. The only way to detect the presence of fish oil is by its smell, and even this is sometimes uncertain. Linseed oil is also adulterated with oils of resin and pine, and these are difficult to discover except by long experience.

Before priming the painted finish, all knots, sap, and strong discolorations must be "killed" with a strong coat of shellac to prevent the staining which would otherwise occur. The painter must be required to examine the finish and report any defects, which must be remedied by the carpenter, and all finish should be gone over with sandpaper before each coat. As regards the color of the priming coat, white or almost any very light tint will do. It is often well to include in the contract just two coats—the priming coat and the finishing coat—as the work will then be better done with less opportunity to cover up poor work and less liability to blistering than if three or four coats are applied at once; a third coat may be put on after two or three seasons to better advantage. An exception should be made with regard to sashes, which should have three or four coats immediately.

Puttying. After the application of the priming coat, all the nail holes and cracks must be stopped with putty, the nails having been previously "set" by the carpenter when the finish was put up.

Method of Applying Final Coat. The final painting of the exterior will naturally begin with the roof and be carried downward so that portions already done will not be spattered by subsequent operations. If the roof shingles are to be painted or stained they should have been dipped in the paint or stain, for a distance of at least two-thirds from the butt, before being laid. This is a tedious process but is well worth the extra trouble and expense. Another method is to paint each course of shingles as it is laid, but this is fully as objectionable a process as dipping. One or the other of these methods should be employed, however, if a painted roof is required, for the painting of a shingled roof after laying is fatal to the wearing qualities of the shingles. The reason is that the wet paint runs to the butt of the shingles and, trickling over the lower edge, forms a small dam or barrier on the shingle next below. Any water falling on the roof is held back by this dam under the butt of each shingle until it evaporates, meanwhile rotting the shingle upon which it lies and the butt above. This is especially damaging on a roof of low pitch.

Whichever of these methods has been used, however, the coloring of the roof shingles will have become hard by the time the walls are painted so that there will be no staining of the work below.

While it is essential that the first coat should be of lead and oil, for the subsequent finish this is not so important. Some of the patent mixed or chemical paints are convenient and will last well, especially away from the seacoast. Paint should be applied by long strokes parallel to the grain of the wood, and no portion of work should be started in the morning which cannot be finished or carried to some definite stopping-place before night, as work done at different times can never be neatly joined. The back of lattice work should be painted and also all conductors, and the metal finish and roofs. Canvas roofs are best treated by being dampened and given a good coat of oil with yellow ocher, then two or three coats of lead and oil paint.

The use of turpentine is to be avoided in exterior painting, for turpentine does not resist the action of water and so will not preserve work exposed to the weather. As oil possesses a natural tendency to discolor white paint, it is customary to mix turpentine with the oil when an absolute white is desired, but in dark colors this is not necessary and boiled oil only should be used, unless a dryer is needed.

Choice of Colors. Concerning the choice of a color for the exterior of the building, a few general suggestions may be properly made here. In the first place, it is of prime importance that the house should be suited in its exterior colors to the surroundings.

If the house is to be surrounded by plenty of growth, such as trees and shrubs, so that the tints of vegetation will predominate, the tendency may well be toward shades of green, yellow, or brown, which will harmonize with the changing effects of the growth. On the other hand, if the situation is one where rocks and ledges will necessarily lend a grayish tone to the surroundings, the house may be suitably painted in shades of gray.

For a colonial design, such as we have adopted, the old-fashioned idea of painting the trimmings white with the body of yellow ocher or gray, may be properly considered. Of these, the gray body will prove the more lasting as the yellow ocher often becomes mildewed when exposed to continued dampness. In general, light colors last better than dark colors and do not "draw" the joints of the finish.

Use of Stains. For shingled houses, stains of various colors and ingredients are often used. These are not so durable as paint, but they have the merit of preserving the texture of the shingles, which is completely lost by the application of paint. Creosote stains, pine-tar stains, and oil stains may be obtained. The creosote stain acts as a preservative for the wood, especially if the shingles are dipped before being laid. In the lasting qualities of these stains there is little choice; creosote and tar both disappear in time through the action of sun and rain, while the tendency of oil stain is to blacken or mildew.

Weathered Exteriors. In some situations a preference may be had for an unpainted exterior, the desired effect being obtained by the action of the elements. In this case, shingles should be used for the covering, as clapboards or siding are likely to split if not protected with paint. In any case, the exterior finish and moldings should be painted or they will warp and twist out of place.

INTERIOR PAINTING AND STAINING

Painting. While the same principles apply to the inside painting as to the outside, more pains must be taken in the work. Puttying must be done with the most particular care, and great skill in the application of the finish is needed. If the woodwork is to be painted, all knots and pitch must be thoroughly protected by shellac, even to the extent of shellacking the whole finish if it is necessary. For inside painting zinc is largely used instead of lead and is often preferred, as it has no tendency to turn yellow, as lead will sometimes do, in rooms which are not well lighted. Tastes vary as to the kind of surface for the painted wood. If a dull finish is preferred, it may be obtained by mixing the last coat of paint with clear spirits of turpentine instead of oil. Oil gives a somewhat glossy finish, and varnish mixed with the last coat gives a high gloss. The so-called enamel finish is very popular, and is obtained by the application of five or six coats of paint, each coat rubbed down with pumice and oil, the last coat being of a prepared enamel.

Staining. Staining in various tints is a popular way of finishing many interiors. This is done sometimes to change the natural color of hard woods, like oak, but more often to give a desired tone to softer woods such as whitewood or cypress.

Stains are, in general, of three kinds—water stains, oil stains, and spirit stains. The richest color effects are produced with water stains, for the reason that their work is performed by absorption and there is thus less tendency to obscure the grain of the wood. Oil stains are superior to water stains in preserving the wood and, because they do not freeze, their use in cold weather is an advantage, but the result is a loss in clearness of grain and color effects. For renewal of old work, oil stains should be used as the previous finishing will prevent proper absorption of the water stain. Spirit stains tend to strike into the wood by evaporation, requiring about twice as much to cover the same area as water or oil stains, and they are not extensively used.

Natural Finish. When a natural finish is desired, the treatment will vary from the simple application of a coat or two of oil, which makes the cheapest and poorest finish, to five or six coats of shellac, rubbed down, which gives the most costly and best of all finishes. The treatment depends upon the wood and on the finish desired. We find that our painting specification has been very carefully drawn. The hardwood finish, after cleaning, is to have first a coat of oil or paste filler; this is to be cleaned off and four coats of shellac applied, each coat, except the last, to be rubbed down when dry with fine sandpaper, and the last to be rubbed to an eggshell gloss with pumice stone in oil. The hard-pine finish of the service portions of the house will have a good coat of oil to bring out the grain of the wood. This will be smoothed by sandpapering, and then given a coat of spar varnish, rubbed down, and a final coat of the same varnish, flowed on and left shining.

Processes of Finishing. *Preparation of Surface.* The first requisite for good work is that the surface of the wood shall be smooth and clean. This can best be secured by a careful sandpapering of all finish until it is perfectly smooth, when all traces of dust should be removed. If stain is to be used it may be then applied and, after drying, the wood lightly sandpapered to bring out the high lights and smooth the grain which will be raised somewhat by the application of the stain. A second coat of very dilute stain lightly applied with a cloth will often improve the grain. This may be followed by a thin coat of shellac to protect the solid parts of the wood from absorbing too much of the filler, thus heightening the contrasts and preventing the muddy appearance sometimes seen.

Filling and Finishing. The wood is now ready to receive the filler which should be used on open-grained woods such as oak, ash, chestnut, mahogany, etc. It may be either a paste filler or an oil filler, preference generally being given the former. This is applied in a thick coat, the surplus wiped off with a cloth, and the whole sandpapered lightly. After filling, another coat of shellac may be put on and sandpapered, and this may be followed by two or three coats of varnish or shellac, according to the finish desired.

Shellac and Varnish. The choice of shellac or varnish for finish depends upon the use, condition, and situation of the work.

In damp situations, or where the finish will be subjected to the action of water to any extent, it is better to use varnish, as the effect of water is to turn shellac white. Varnish when perfectly dry is not affected by ordinary applications of water. For this reason, if there is any suspicion that the wood is not thoroughly seasoned, it is safer to use varnish in direct contact with the wood as the final seasoning of some of the more "sappy" woods, such as cypress or hard pine, will sometimes produce enough moisture to whiten the shellac, even under subsequent coats of varnish.

In kitchens, pantries, bathrooms, and, in general, in the whole service portion of a house, it is better to use varnish, as the application of water will be more general in these parts than in the main rooms.

Rubbing-Down. The rubbing-down of shellac or varnish is a protection against whitening, and for this reason, besides the gain in appearance, every coat, especially in finishing with shellac, should be rubbed down. This rubbing-down may be done with fine sandpaper, or haircloth, or curled hair, and the last coat may be treated in various ways, according to the finish desired. To obtain an eggshell gloss for the final surface, the last coat should be rubbed with pulverized pumice stone and raw linseed oil. For a dull finish, water instead of oil may be used with the pumice, and for a highly polished surface, a rubbing with pumice and water may be followed by polishing with "rotten stone" and water. Work that is to be polished should never have less than three varnish coats, but an eggshell gloss may be obtained with two coats.

Floor Finish. To obtain permanent wearing qualities in the finishing of floors is a troublesome matter. The elastic varnish which we have used for the standing finish requires a different treatment when subjected to the wear and tear of floors. Referring to the specifications, we find that the floors are to be stained as approved, and the oak, which is an open-grained wood, is to receive a coat of oil filler; this brings out the grain of the wood and the floor is then ready to receive three or four coats of shellac, each sandpapered as before, and the last coat rubbed with pumice stone in oil or water to a dull finish. For floors of maple, birch, or any close-grained wood, the oil filler would be of no use and its place should be taken by extra coats of shellac. For the hard-pine floors of the kitchen, back halls, and bathroom, which are subjected to a great deal of use and more or less water, a satisfactory finish may be obtained by giving simply two coats of oil with turpentine dryer added to prevent the dust from sticking as it would to clear oil.

A finish less expensive than the shellacked finish for hardwood floors is obtained by using wax polish which is applied to the wood after the filling or, better, over one or two coats of shellac. This wax polish is a paste which enters the pores of the wood, dries in a few hours, and can then be polished with cloths, or by dragging to-and-fro over the floor weighted brushes, which are sold for the purpose. By keeping a brush and the wax at hand, any worn spots on the floor can be easily renewed and the whole kept looking well indefinitely.

A first-class job of finishing should never be hurried, but each coat should be thoroughly dry before the next one is applied. Varnish should be applied at a temperature of about 70 degrees Fahrenheit, and this temperature should be maintained until the drying is complete. Clean brushes should be used at all times, and a rising of dust in a room should be wet down and checked.

Miscellaneous Details. Besides the standing finish and floors, miscellaneous parts must receive the painter's attention. Pulley stiles of windows must be oiled, sashes drawn, exposed brass piping shellacked, and thresholds oiled or varnished. All of these minor details need the attention of the superintendent or they will be overlooked. Other than this, the supervision of the painting work involves mainly seeing that the best of materials are used. To this end it will be necessary to insist that all paints shall be mixed at the building, and that all materials are of the specified kind and are brought to the building in the original cases or kegs.

Wall Surface. *Tinting.* It will generally be found necessary to tint or fresco the ceilings and walls which are not covered with paper or hangings. This is a matter which needs careful workmen who understand the preparation and application of the colors.

Much depends upon the first or sizing coat, which should always be applied before tinting or frescoing of any kind is done.

Oil Paint. For the service portions of the house and the untiled walls of the bathroom, oil paint or some washable compound should be used. If oil paint, the walls should be sized and at least three coats of paint applied. Oil paint, unless stippled or otherwise "flatted", gives a shiny wall surface which is not so pleasing to look at as a flat coat, and besides shows the blemishes more. For this reason flat tints which can be washed have been put on the market, of varying composition, all designed to give a dull surface without the added cost involved in stippling or other treatment of oil paint. These are marketed under various names, usually suggestive of their "flat" qualities, and in a large range of colors, sample cards of which may be obtained of the manufacturers.

Glazing. *Common Glass.* It is usually the custom to send the sashes to the building all glazed, so that the superintendent needs only to see that the glass is whole and of the specified quality. Common window glass is called sheet or cylinder glass, and is rated as double or single thick, and as first, second, or third quality. Formerly all glass was imported from France or Germany, but American glass has come into general use in the greater part of the United States.

In the eastern States, window glass is still imported and it is customary to specify German glass for the best work. For lights up to twenty-four inches in width, single thick glass may be used; this is about one-sixteenth of an inch in thickness, while double-thick glass is about one-eighth inch.

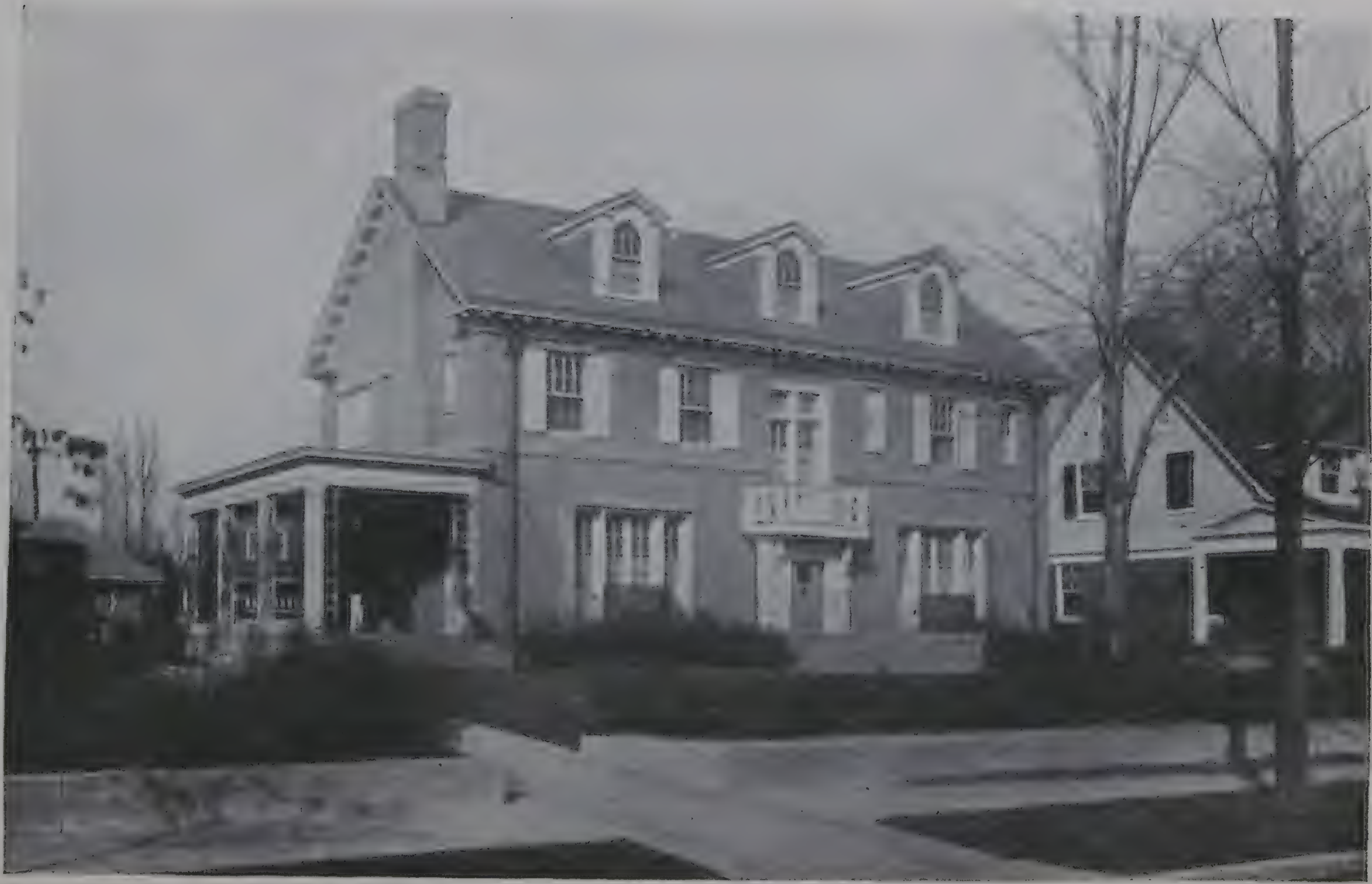
The best quality of common American glass is known as AA, the second as A, and the third as B. Sheet glass is made by blowing the molten glass in a cylinder about fifteen inches in diameter. This is trimmed and cut longitudinally and heated until it can be opened out flat. Sheet glass always retains a vestige of its curvature. Between first and second quality glass it is difficult to distinguish except by practice, but defects or unevenness may be seen at once. Plate glass is always readily distinguished by its polish and its absolute freedom from imperfections of any kind.

Plate Glass. For lights more than five feet square, plate glass must be used. This may be obtained in three grades—French plate and two grades of American plate. French plate, and the first or silvering quality of American plate, are used almost entirely for mirrors, while the second quality of American plate is used for glazing.

American glazing plate is made in one quality only, and is usually $\frac{1}{4}$ inch thick for ordinary sizes, but is necessarily thicker for large lights. It can be obtained in sheets as large as 12 by 17 feet. Plate glass is absolutely straight, being cast on a perfectly flat cast-iron table and rolled to the required thickness. The rough plate thus formed is carefully examined for flaws which are cut out, leaving as large a sheet as possible, which is polished. French plate may be distinguished from American plate by the color, when looked at endways; the French glass shows perfectly clear and white, while the American glass has a bluish color.

Crystal Plate. A kind of plate glass called crystal plate is made about $\frac{3}{16}$ inch in thickness. This is used for railway cars and in places where thin sashes must be used or a saving in weight is desirable.

Final Inspection. With the departure of the painter the house is usually complete, and ready for the architect's final inspection and acceptance. This inspection should be careful and thorough from top to bottom, and no certificate of acceptance should be issued, until the architect is satisfied that everything has been done which is actually called for or reasonably implied by the plans and specifications.



RESIDENCE OF CLIFFORD OFF AT PEORIA, ILLINOIS

Hewitt and Emerson, Architects, Peoria, Illinois

A rather interesting example of a symmetrical exterior fitted to an unsymmetrical plan. The house is of brick veneer construction with a slate roof. Cost about $14,000

BUILDING SUPERINTENDENCE

PART II

CITY BUILDINGS

FOUNDATIONS

The requirements of city buildings, which are for the main part similar to the practices which we have already considered, are, nevertheless, in many essentials, distinct. In the first place, the circumstances of situation, soil, and surroundings differ from suburban or rural conditions. Instead of being able to establish our building to meet our individual tastes, we shall find that the sidewalk and yard levels are already established, and that in some localities the level of the cellars or basements is restricted. The lines of our building will also be determined, in a great measure, by fixed lines and restrictions, so that much more preliminary work will be needed to make the most of the existing conditions with which we find ourselves confronted.

Party Walls. Of great importance in laying out our building are the existing agreements with regard to party walls. In most cases it will be found that there has been signed an agreement relating to the construction and use of party walls. The usual arrangement is that the party who first builds shall build and pay for the wall, which is erected one-half on each side of the party line, and that the adjoining owner shall have the right to use and acquire the half of wall which stands upon his side of the line, by paying to the party who has already built, the cost of one-half of the wall as erected.

As buildings of different heights require walls of different thicknesses, it is usual to agree that no wall shall be primarily erected which extends more than 6 inches beyond the party line, so that if one owner desires to erect a building which will require a greater thickness than 1 foot for the party wall, he must erect all except 6 inches of the thickness of the wall upon his own land. While a party wall agreement will probably be a matter of record, which can be looked up in the proper place, much time may often be saved by seeking some information on the spot.

If the land on either side of our lot is already occupied by a building, the conditions of the wall finish will be likely to afford data upon which we can work. If the finished brick or stonework covers apparently only one-half of the wall, leaving a surface of rough brick set back from the face or ashlar line, Fig. 122, it will indicate that the wall is a party wall, as it is the usual practice for each owner to stop the front of his building at the party line. If, on the other hand, we find the finished work covering the wall completely, Fig. 123, we may assume that the wall in question is not a party wall, but a wall built wholly upon the land of the adjoining owner. This evidence will be confirmed if, upon measuring the distance between the two side lines of the lot in question, we find it to agree with the figures upon the surveyor's plan with which we must be provided before laying out our own plans. The matter of party wall rights is, however, so important that it cannot be settled by mere observation, satisfactorily enough to permit building operations, and we shall, therefore, need to apply to our client for a copy of any agreements or restrictions, and proceed to plan and construct the new buildings in accordance with them.

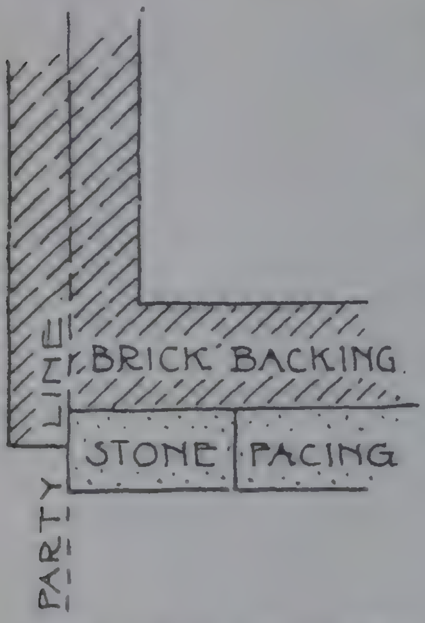


Fig. 122. Finish at Party Wall

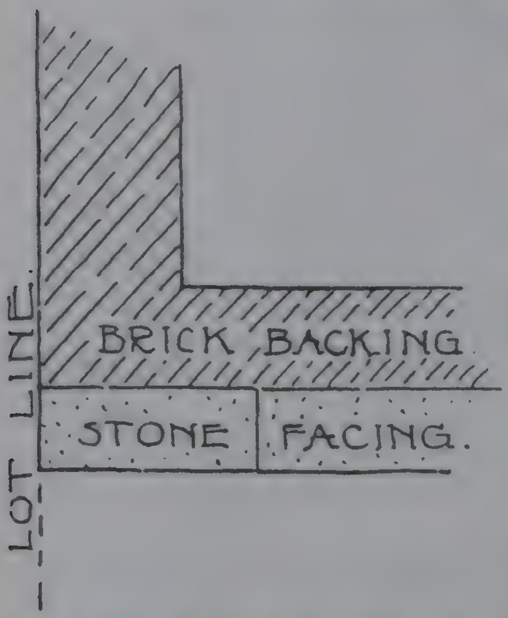


Fig. 123. Finish of Wall When Not a Party Wall

Knowledge of Soil Foundation Important. If the nature of the soil upon which we are to build is not known, we must have borings made to determine the composition at different levels. If two borings on opposite sides show about the same character, it will be sufficient evidence of general uniformity in the soil, but if these vary, then borings should be made all around. Rock, clay, or gravel bottom will require only that our foundations shall be made wide enough to distribute the weight of the building, with its contents, over an area sufficient to sustain it. The bearing power of rock varies from 10 to 30 tons per square foot, of dry clay from 4 to 6 tons, of gravel from 8 to 10 tons. If, however, the soil consists of mud or filled land, such as is found on the borders of lake or ocean, it will be necessary to drive piles, upon which the footings shall be supported.

Pile Foundations. Piles may be of wood, cast iron, concrete, or steel, but for ordinary buildings they are usually made from the trunks of trees, and should be straight and sound and, for heavy buildings, at least 8 inches in diameter. Spruce, hemlock, Georgia pine, and oak are the principal kinds of wood used for piles. The customary method of driving piles is by repeated blows from a block of iron called the hammer, which works up and down between the uprights of a machine called a pile driver.

Piles should be spaced not less than 2 feet, nor more than 3 feet, on centers, and they must be cut off below low-water mark. The level at which piles are to be cut off is given by the building laws of most large cities and is established at a point which insures the pile being at all times under water. Under these conditions the piling will be subject to no decay, whereas alternate conditions of moisture and dryness soon result in the rotting of the piles.

Supervision. The superintendence of piling consists first in an examination of the piles as they are delivered, to see that they are of the requisite length and diameter, and sound and straight. The lines of the building must be carefully established, and small stakes driven to fix the position of every pile. This should be verified by the superintendent according to the piling plan furnished. When the actual driving of the piles begins, there should be kept a complete record giving the length of pile, the number of blows, and the distance which the pile has sunk at each of the last ten blows. From this data the bearing capacity of the pile may be computed.

Besides keeping this record, the pile should be carefully watched while being driven, to see that it does not get out of line and that the head does not "broom" or split excessively. If there is danger of this, the head of the pile should be bound with a wrought-iron strap or a cast-iron cap. When the piles have been driven, trenches wide enough to accommodate the stone levelers must be excavated and kept free from water to a depth sufficient to allow the sawing-off of the piles at the required height. This is usually done by means of a cross-cut saw operated by two men, and the tops must be cut off at a level with each other. Piles exposed to tidewater are usually driven with the bark on.

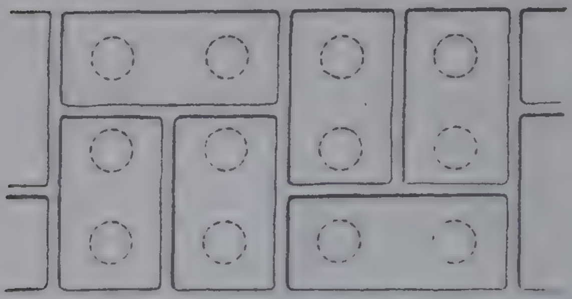


Fig. 124. Capping for Three Rows of Tiles

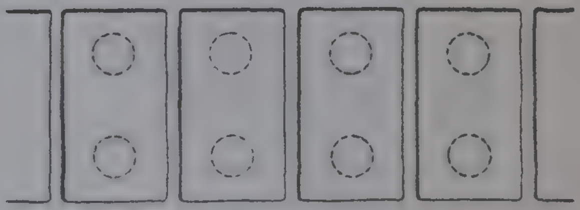


Fig. 125. Capping for Two Rows of Tiles

Footings of Stone and Concrete. Whether the bearing is piles or the natural earth, the bottom of the foundation usually consists of large stones or of concrete. If three rows of piles are used, they may be covered as shown in Fig. 124. Two rows of piles are generally capped by a series of levelers laid across the trench, Fig. 125. A footing on earth will be laid in a like manner, of the width made necessary by the load to be borne and the nature of the soil. These wide footings which may be of stone, brick, or concrete, are designed to spread the weight over a large area and also to add stability to the wall.

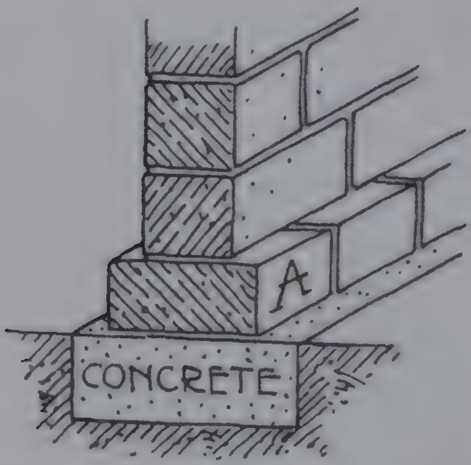


Fig. 126. Foundation Trench Filled with Concrete Footing

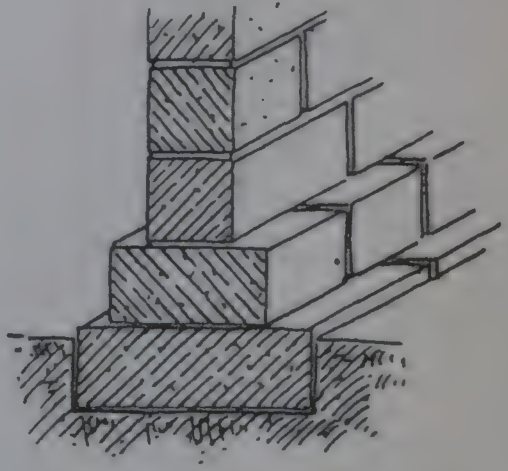


Fig. 127. Section of Foundation Using Stone Footing

For nearly all buildings on solid ground, concrete footings are probably the best, and in many cases concrete capping for piles may be used to advantage. Trenches for the footing may be dug below the regular excavation and of the exact width required, and into this the concrete may be tamped, Fig. 126. If this concrete is much wider than the wall over it, a stone leveler may be placed on the top, as shown at *A*.

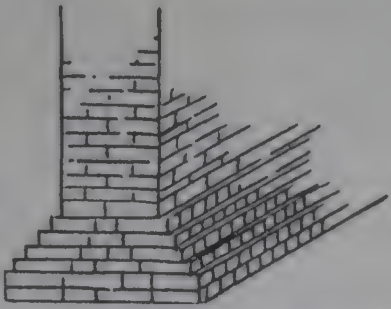


Fig. 128. Foundation Footing of Brick for Light Building

If preferred, stone footings of a similar character may be used, Fig. 127, and for light buildings, where stone is hard to obtain, brick footings may be used. If the footing is brick, the offsets should never be more than one-quarter of a brick, and the outside work should be all headers, with a double course at the bottom, Fig. 128. This course should be of hard-burned bricks, thoroughly wet if the weather is dry, and should be laid in a bed of mortar spread on the bottom of the trench.

Too much care cannot be taken in making sure of a good foundation. If important footings are made of concrete, an inspector should be on hand during working hours, to see that the concrete is mixed in proper portions, that it is put in to the full thickness directed, and tamped and leveled. The trenches must be kept free from water until the cement has set, for the water would separate the cement from the sand, and render it utterly worthless. If the footing is of stone the presence of a few inches of water will do no harm, but the footing must then be bedded in firm sand or gravel instead of cement.

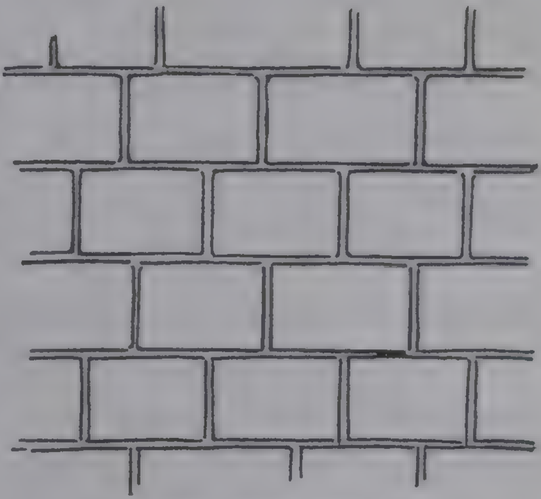


Fig. 129. Block Stone Wall

Foundation Walls. *General Specifications.* The foundation walls of a city building above the footing course are sometimes built of stone and sometimes of concrete, and brick may be used to advantage for the party wall where there is to be a cellar both sides. For the heavy outside walls of buildings three or more stories in height, it will be necessary to use concrete or block stone. The latter are stones roughly fashioned to dimension and are generally from 18 inches to 2 feet in height, by the full width of the wall, Fig. 129. Being brought nearly even and square, not much mortar need be used, and this should be of clear cement and sand below the grade line.

Rubble Walls. For a foundation of a lighter character, rubble stone may be used. This consists of stone split from a ledge, the only preparation being to break it up with a stone hammer and to square one edge and face. As these stones are irregular in shape and thickness, considerable mortar will have to be used, and the character of the mortar and the filling of voids will need special attention. An important element in the strength of a rubble wall is the bonding or the lapping of stones over each other. The stones should be laid in irregular courses and leveled off to a horizontal joint about every 2 feet, and a bond stone should be put in at intervals of 4 or 5 feet. Most city laws require a certain proportion of bond stones, and if nothing is said, a through bond stone should be inserted into every 5 or 6 square feet. Care must be taken that the stones are bonded also in the direction of the length of the wall, so that no vertical joints may appear running through three or four courses. Outside of the bonding, other points in laying the stones must have our attention. All the stones must be set as nearly as possible on their natural bed, that is, with their split surfaces horizontal. Angles and corners must be carefully laid with large stones bonding across each way, as in Fig. 130.

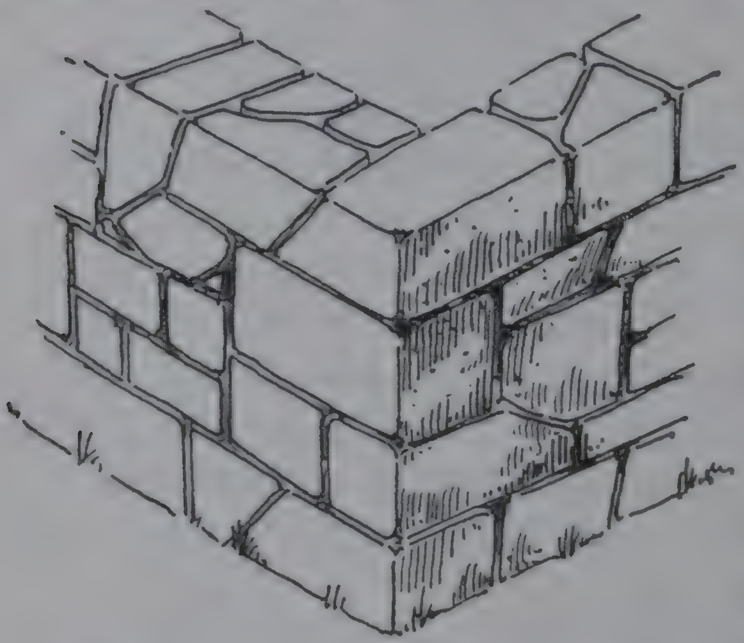


Fig. 130. Proper Bonding of Corner of Rubble Wall

Block Stone Walls. With a heavy foundation wall of block stones, where each stone is of the full thickness of the wall, the main care will be to obtain a good bond, with level and plumb joints. Openings for pipes should be left when the walls are built, as it may be difficult to break an opening after the walls are carried up.

Use of Derricks. All of the stones which are suitable for the heavy walls which we have described, are large and will require the use of derricks in the handling. If the building is to be one of great size or height, a system of three or four large derricks will probably have been started, swinging from some central scaffold, and guyed to this and to each other. For a building of but three or four stories, however, the builder will probably use a series of smaller derricks, each supported by its own guy ropes. The superintendent should make sure that the ropes are strong and not frayed, that the mast and boom are neither cracked nor sprung, and that the running gear is strong and shipshape. The securing of the guy ropes is a very important matter, and should be watched by the superintendent. Although it belongs to the contractor to do, a careful inspection by the architect will doubly insure the safety of all concerned. In suburban or out-of-town work the guys are usually secured to a convenient tree, and this should be a young or evidently sound tree; if posts have to be put down, as is necessary in the city, they should be set deep in the ground with the earth well tamped in again. The guys must be at all times drawn taut, as a loose guy will be given a sudden and dangerous strain if a heavy stone is swung around so as to bring its weight upon it.

The derrick allows heavy stones to be carefully set, and this will be especially noted in the handling of the capstones for the piles. These will have been selected for an even bed and can be shifted until they rest immovable on the piles. In bedding, the heavy stones may be held suspended over the place where they are to lie while an even bed is being prepared, and, if necessary, the stone may be lowered and then raised again before the final setting, so that the impression will show where the bed needs fitting.

Thickness of Walls. The thickness of foundation walls in all large cities is controlled by laws which in general require that walls to a depth of 10 or 12 feet below the ground shall be, if brick, 4 inches thicker than the walls above; and if stone, 8 inches, with an increase of 4 inches for every ten feet below this. In clay, which is more seriously affected by frost than gravel, it is a good plan to build foundations with a batter on the outside of 6 to 12 inches, as in Fig. 131, so that any movement of the earth will readily free itself from the wall, which should be made smooth on the outside with cement.

Areas. Areas are often required, to give light or access to basements, and these need a retaining wall to keep back the earth. Stone should be used for areas of any size, and, in excavating, the bank should be disturbed as little as possible and refilled carefully. If the area is not more than 6 or 7 feet deep, a good wall of a uniform thickness of 20 inches will be sufficient, but if the area is deeper, the wall should be made wider at the bottom and battered. If the wall is more than 10 feet long, cross-walls or arches should be built to connect with the main building. The bottom of the area should be carried at least 6 inches below the sill of window or door, and covered with stone flagging, brick laid in cement, or a concrete bottom made with a small cesspool, with cover, connected with the main drain.

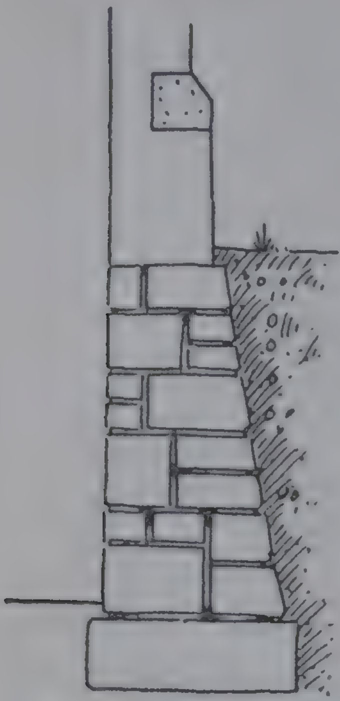


Fig. 131. Wall with Batter

Vaults. The space under the sidewalks and entrance steps or porches is often utilized for coal or general storage purposes. This requires a wall at the street line which is heavy enough to sustain the pressure of the street and the weight of the sidewalk. If it is possible to divide this space so that the partition walls can be run back to the main building about every ten feet, the construction can be simplified; but if an open space is required, a very heavy wall must be built at the street line, and from this wall to the building, steel or concrete beams laid, which will buttress the top of the street wall and support the weight of the sidewalk as well. Brick arches may be turned between the steel beams and leveled up for the sidewalk, or a concrete or flagstone sidewalk may be constructed over

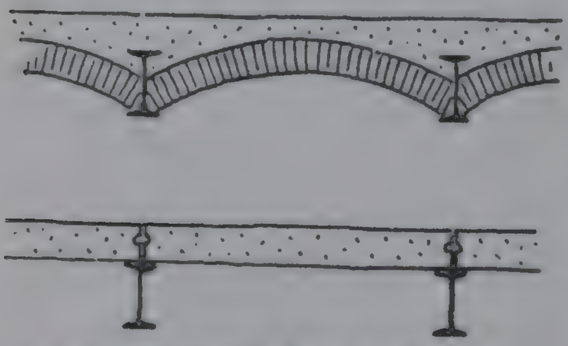


Fig. 132. Brick Arches or Concrete Slabs for Sidewalk Construction

them, Fig. 132. If brick arches are turned, to be covered with an ordinary brick paving, the tops of the arches should be coated with hot asphalt. Any of the modern forms of fireproof floor construction may be used for the sidewalk covering, finished with concrete or granolithic surface.

Methods of Waterproofing. As a protection against dampness, the outside of all cellar and vault walls in wet situations should be coated with hot asphalt or Portland cement. Asphalt, applied while boiling hot in two or more coats from top to bottom, is considered the more lasting if the ground is very damp, as Portland cement is affected by frost and is easily cracked by settlement of the walls, while asphalt, having considerable elasticity, remains sound and tight. Coal tar is sometimes used, but that gradually becomes brittle and crumbles away.

Integral Method. The so-called "integral" method of waterproofing has been developed to a high degree of efficiency. This consists of the application of a preparation which penetrates or adheres to old or new masonry or concrete and forms a bond that withstands a hydrostatic pressure limited only by the strength of the masonry to which it is applied. The most effective of these compounds contains a bituminous material, chemically prepared so that it may be combined with water and used in proper proportions in mixing the cement instead of plain water. This mixture is applied to the walls in three coats of about $\frac{1}{4}$-inch thickness each. For floors, a single coat of an inch thickness may be applied.

Membrane Method. Another method of waterproofing is the membrane method, in which a thin layer of water-resisting felt or other fabric is held in a position to withstand the water pressure by the weight of concrete or other masonry laid upon or against it.

Simpler Methods. For work above ground where the resistance is against a driving rain or continued soaking without a water pressure to contend with, simpler methods may be used, such as the application of a transparent waterproof coating to the exterior masonry, or an adhesive coating on the back of the wall, which may be plastered upon if desired. Compounds are also prepared which may be mixed with the mortar in which the masonry is laid, in cases where the materials of the wall are nonabsorbent, or mixed with the cement plaster in the case of plastered exteriors.

BRICKWORK

In the superstructure of a city building of ordinary height, say up to five or six stories, except in the so-called skeleton construction, we shall usually find that brickwork forms the greater part of the wall. The face is often finished with stone, either rough or cut, but the backing, and frequently the face as well, is usually constructed of some form of brickwork, so that bricks of one kind or another are probably more extensively used in the construction of city buildings than any other material.

BRICKS

Essential Qualities. The advantages of bricks over stone are that the bricks are practically indestructible, either from the action of fire or the elements, and that they are less expensive and more easily handled. Good building bricks of the different kinds should be sound and free from flaws and stones or lumps of lime, uniform in size, and square, hard, and not too absorbent. A good hard brick will ring distinctly when struck by another brick or by a trowel, and it should not absorb more than 10 per cent of its weight in water. In selecting bricks from a quantity delivered, the hard and usually the darker bricks should be culled for the outside walls, while the lighter bricks should be used for backing and the inside courses.

Varieties. It is customary to speak of common bricks, face bricks, etc. Let us pause and consider just what is meant by these terms. *Common bricks* include all rough, unpressed bricks which have had no special care taken in their manufacture. These, according to their position in the kiln, become burned to varying degrees of hardness. *Arch bricks* are those which from being near fire become burned to a great degree of hardness, and are often warped, vitreous, brittle, and weak. *Red bricks,* which compose the bulk of the kiln, are those burned with an even and moderate temperature. *Salmon,* or *soft bricks,* are those which are found at the top of the kiln and are usually underburned. They are good only for inside courses and for lining chimneys.

Face bricks, in which general term are included pressed bricks, molded bricks, etc., are made or re-pressed in a dry-press machine. Face bricks are more expensive than common bricks and are generally used for facing exterior walls, for fireplaces, and for molded work. *Enameled bricks* are bricks whose faces are covered with a coat of enamel of selected color. The true enameled brick is a very expensive article, and most of the bricks called by this name are glazed bricks, the difference being that the true enamel is fused into the clay and is opaque in itself, while the glaze is formed by coating the surface with a colored film and covering this with the transparent glazing. This film is apparent on chipping off the glazing, while the true enamel shows no line between the body of the brick and the surface. Both glazed and enameled bricks are impervious to moisture and are excellent for the facing of halls, courts, or wherever a light, clean, and waterproof surface is desired.

In addition to the kinds already mentioned, special bricks are made for special purposes, as fire bricks for furnace lining, etc., which are open-grained or porous to admit of a rapid loss of heat; and paving bricks, which are burned to vitrification to withstand the wear of travel and the action of frost.

Sizes. The sizes of bricks vary with the maker and with local customs. Common bricks in New England average $2\frac{1}{4}\times3\frac{3}{4}\times7\frac{3}{4}$ inches; in the western States, about $2\frac{1}{2}\times4\frac{1}{8}\times8\frac{1}{2}$. Face bricks are more nearly uniform in size, and average about $2\frac{3}{8}\times4\frac{1}{8}\times8\frac{3}{8}$ inches. Pressed bricks are also made in a thinner pattern, $1\frac{1}{2}\times4\times12$ inches, a style known as Roman brick.

MORTARS

All mason work below ground should be laid in cement mortar, and all arches or heavily loaded piers as well. In many city laws the use of cement mortar is required up to a certain proportion of the height of the wall. Cement mortar of some kind should be used for setting cornice stones and wherever the work is especially exposed. For all work under water, for large arches, and for tops of chimneys, Portland cement should be used, and Portland cement may be mixed with Rosendale to make a strong, quick-setting mortar. Portland cement and lime may be mixed to give a strong light-colored mortar which is much used in England for face brickwork.

Sand. The proportion of sand in mortar should vary with the kind of cement and the use for which the work is intended. With Rosendale cement, the proportion of sand should not exceed 3 to 1, and for piers, 2 to 1. Portland cement may contain sand in the proportion of 4 to 1, and lime mortar 3 to 1. The object of using sand in mortar is to prevent too much shrinkage, and also to secure a material cheaper than lime or cement. Its functions are mechanical rather than chemical. Sand strengthens lime mortar by supplying a base to which the particles of lime adhere more firmly than to each other, but its presence in cement mortar is a weakness. In all cases a thorough mixing is essential, the object being so to intermingle the particles that no two grains of sand will lie against each other without a film of cement between. The cement and sand should be mixed dry, the process being to spread them in layers and then to turn and work the mass until it is thoroughly mixed, when water is added in sufficient quantity to obtain mortar of the desired thickness.

If too much sand is added, the mortar will stick to the trowel and will not work easily. The superintendent should become familiar as soon as possible with the appearance of good mortar so that he can tell readily whether too much or too little sand has been added. If the mortar slides easily from the trowel it is usually of the right proportion. In ordinary practice, the lime and sand are mixed as soon as the lime is slaked and allowed to stand until needed, but it is better not to add the sand until the mortar is wanted. Coarse sand makes a stronger mortar than fine sand; fine, loamy sand, although it works more easily than sharp, coarse sand, does not make a sufficiently strong mortar.

Lime. Lime is now manufactured in nearly all parts of the country, but differs in character in different localities. In using a lime which is not already familiar, some inquiry should be made as to its properties, especially if used for plastering. Good lime should, in general, have no cinders or clinkers, should contain less than 10 per cent of impurities, and should be found in large lumps which will slake readily in water, making a soft paste, free from residue or "core"; it should, further, completely dissolve in soft water. Slaked lime, or "lime putty" as it is commonly called, will keep indefinitely if protected from the air so that it does not dry. This protection is usually secured by covering the lime with sand in the bed in which it is slaked. Lime before slaking will absorb moisture from the air and become air-slaked; this destroys its strength, and care should be taken that all lime is carefully sheltered from dampness until used.

Setting and Durability. Lime mortar does not possess the setting quality of cement, though it gradually hardens by exposure to the air. Common lime mortar does not harden under water or in damp situations, but in dry places where there is ample exposure to the atmosphere, it will set hard enough for all ordinary uses of brickwork, except arches and piers and structures where excessive loads may be applied.

Hydraulic Lime. Some limes after burning contain enough clay or silica to acquire the property of setting under water. They are called hydraulic limes. This lime, formerly imported from England and France, is now employed to a very slight extent, as its special quality is more easily and profitably obtained by the use of the abundant, easily made cement.

Cement. Cement may be divided into two classes—natural cement and artificial cement.

Natural Cement. This is obtained by burning limestones which contain a large proportion of clay. A powder is formed which, when mixed with water, sets quickly either in air or in water. Natural cements are made in many localities throughout the country, Rosendale cement being probably the best-known brand, and one which is usually of good quality and easily obtained.

Portland Cement. Of artificial cements, the most widely used is Portland cement; this is of English origin and derives its name from the resemblance of a troweled surface to Portland stone, one of the most common building stones of England.

Portland cement is made by combining in proper proportions carbonate of lime, clay, silica, and iron. This mixture is ground and then burned into a heavy vitreous clinker, a dark porous mass which resembles lava. This clinker is crushed and ground again to a powder and run through fine sieves to make the finished product. It is then seasoned for a time in storage and put into barrels or bags for shipment, one barrel containing 376 pounds net. When shipped in bags the weight is 94 pounds per bag, 4 bags being equal to 1 barrel. A bag of loose cement is about equivalent to 1 cubic foot, and this is the most convenient form for ordinary uses, if care is taken to keep the cement in a dry place.

Portland cement does not, in general, set so quickly as natural cement, but it possesses greater strength, and it has now practically superseded the natural cements formerly extensively used. While Portland cement is of the greatest service in all kinds of concrete construction, it also forms an important ingredient of the mortar with which brick, stone, and other forms of masonry are laid. For this purpose there is upon the market a grade of cement known as sand cement, in which a certain proportion of sand is mixed with the powder and the whole ground to the fineness of cement; this requires less sand in the final composition of the mortar and is productive of satisfactory results. Another prepared cement of a nature similar to Portland cement is known as Lafarge cement, and is useful in setting limestone or marble, since it does not stain like other cement.

Tests. Some idea of the quality of cement may be obtained by observing carefully its appearance upon opening the cask or bag. With natural cement, the darker brown colors indicate, in general, stronger qualities; too dark a color, however, may indicate in an unfamiliar brand the presence of coloring matter, usually lampblack. This may be detected by putting some of the cement into a glass of water, when the lampblack, if present, will separate as a black scum. With Portland cement, a clear gray or bluish color is to be preferred, as a brown color is given by an excess of clay; too strong a bluish cast, however, marks the presence of too much lime. Further tests of cement for ordinary work may be made as described in Part I, but in important engineering construction in which Portland cement is used, the cement should be subjected to careful tests for activity, soundness, and strength, both unmixed and mixed with sand.

To obtain the best results the superintendent should, in general, choose a fine, well-burned cement of average specific gravity, and, for important work, test it frequently. Mixed with sand that has passed a careful scrutiny for cleanness and regularity, such cement should give a smooth and strong mortar.

Protection in Laying. Whether lime or cement mortar is used in the building of a wall, it should be kept at all times protected from the weather until the mortar has had time to become thoroughly set.

BUILDING OF WALLS

Laying Brick. In erecting a brick building it is necessary to lay the carefully chosen bricks upon each other, with a bed of some kind of mortar between. Ordinary brickwork is laid in common white-lime mortar, but for greater strength and durability there is often added a proportion of cement, and for brickwork below ground, cement mortar only should be used. The thickness of the joints will vary from $\frac{3}{16}$ inch to $\frac{3}{8}$ inch, according to whether the joint is to be concealed or made a feature of the work.

The laying of the bricks should be carefully watched, as there is a tendency on the part of many masons to slight this work. The following general observations are given:

Bricks should not be merely laid, but every one should be rubbed and pressed down in such a manner as to force the mortar into the pores of the bricks, and produce the maximum adhesion; with quick-setting cement this is still more important than with lime mortar. For the best work it is specified that the brick shall be laid with a "shove-joint", that is, that the brick shall first be laid so as to project over the one below, and be pressed into the mortar, and then be shoved into its final position. Bricks should be laid in full beds of mortar, filling end and side joints in one operation. This operation is simple and easy with skilful masons, if they will do it, but it requires persistence to get it accomplished. Masons have a habit of laying bricks in a bed of mortar, leaving the vertical joints to take care of themselves, throwing a little mortar over the top beds and giving a sweep with the trowel which more or less disguises the open joint below. They also have a way, after mortar has been sufficiently applied to the top bed of brick, of drawing the point of their trowel through it, making an open channel with only a sharp ridge of mortar on each side (and generally throwing some of it overboard), so that if the succeeding brick is taken up, it will show a clear hollow, free from mortar, through the bed. This enables them to bed the next brick with more facility, and avoid pressure upon it to obtain the requisite thickness of joint. Neglect in wetting the brick before use is the cause of many of the failures of brickwork. Bricks have a great avidity for water, and if the mortar is stiff and the bricks dry, they will absorb the water so rapidly that the mortar will not set properly, and will crumble in the fingers when dry.

Mortar is sometimes made so thin that the brick will not absorb all the water. This practice is objectionable; it interferes with the setting of the mortar and particularly with the adhesion of the mortar to the brick. Watery mortar also contracts excessively in drying (if it ever does dry), which causes undue settlement and, possibly, cracks or distortion. The bricks should not be wet to the point of saturation, or they will be incapable of absorbing any of the moisture from the mortar, and the adhesion between the brick and mortar will be weak. The common method of wetting brick by throwing water from buckets or spraying with a hose over a large pile, is deceptive; the water reaches a few bricks on one or more sides and escapes many. Immersion of the brick for from three to eight minutes, depending upon its quality, is the only sure method to avert the evil consequences of using dry or partially wet brick. Strict attention must be paid to have the starting course level, for the bricks being of equal thickness throughout, the slightest irregularity or incorrectness in it will be carried into the superposed courses, and can only be rectified by using a greater or less quantity of mortar in one part or another, a course which is injurious to the work. A common but improper method of building thick brick walls is to lay up the outer stretcher courses between the header courses, and then to throw mortar into the trough thus formed, making it semi-fluid by the addition of a large dose of water, then throwing in the brickbats (sand and rubbish are often substituted for bricks), allowing them to find their own bearing; when the trough is filled, it is plastered over with stiff mortar, and the header course laid and the operation repeated. This practice may have some advantage in celerity in executing work, but none in strength or security.

A modification of this latter practice, in which the bricks are laid dry and grouted with moderately thin mortar *in every course*, may be successfully used in weather when there is no danger of freezing, and it will make solid work. This is especially suited for footings and foundations of brick where it is necessary that every joint shall be filled, as the thin grouting is more to be depended upon for that than is the average mason.

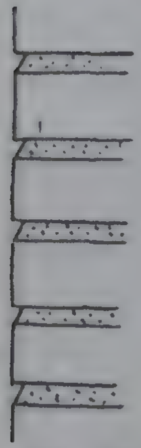


Fig. 133. Struck Joint

Joints. For inside walls which are to be plastered or otherwise concealed, the joints may be simply cut off flush with the trowel, but where the walls are exposed, the joints should be *struck*, Fig. 133. This consists in pressing or striking back with the trowel the upper portion of the joint while the mortar is soft, so as to form a sloping surface from the bottom to the top. *Keyed joints* are formed by running an iron jointer with round or V-shaped edge along the center of the flush joint, giving it a depression and hardening the mortar by the pressure, Fig. 134. *Ruled joints* are made by holding a straightedge under the joint and running the jointer along, making a perfectly straight joint.

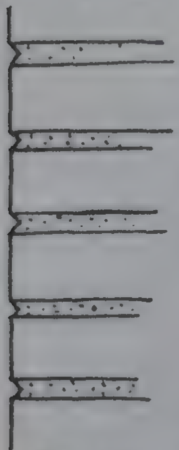


Fig. 134. V-Joint

Bonding. The strength of a brick wall depends not only on the bricks, the mortar, and the workmanship, but on the assembling of the different members, the bond or arrangement adopted for tying together the separate parts and for distributing the effects of concentrated loading. The common bonding consists in laying every fifth or sixth course of bricks at right angles to the direction of the wall,

Fig. 135. These courses are called header courses and serve to tie the wall together. Where the wall is faced with pressed brick and the regular occurrence of header courses would not look well, the face work is tied to the backing by clipping off the back corners of the face bricks, and inserting a course of diagonal headers, Fig. 136. Galvanized steel ties of patented manufacture are extensively used in the East for this purpose, and have proved effective. English bond, the method in vogue in England, consists

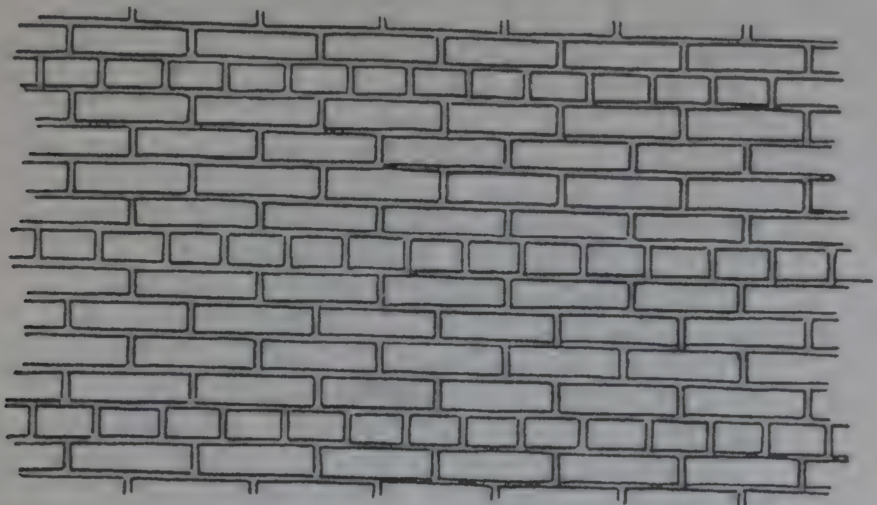


Fig. 135. Common Method of Bonding Brick

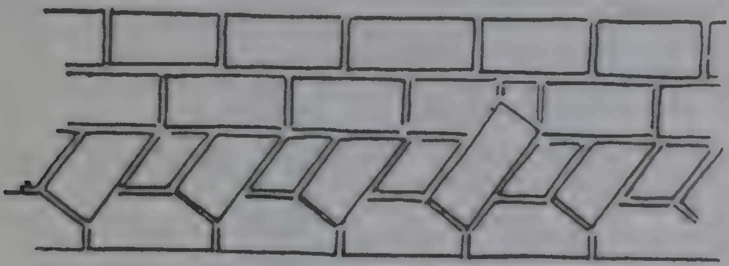


Fig. 136. Plan View of Wall with Pressed Brick Facing, Showing Diagonal Bonding Course

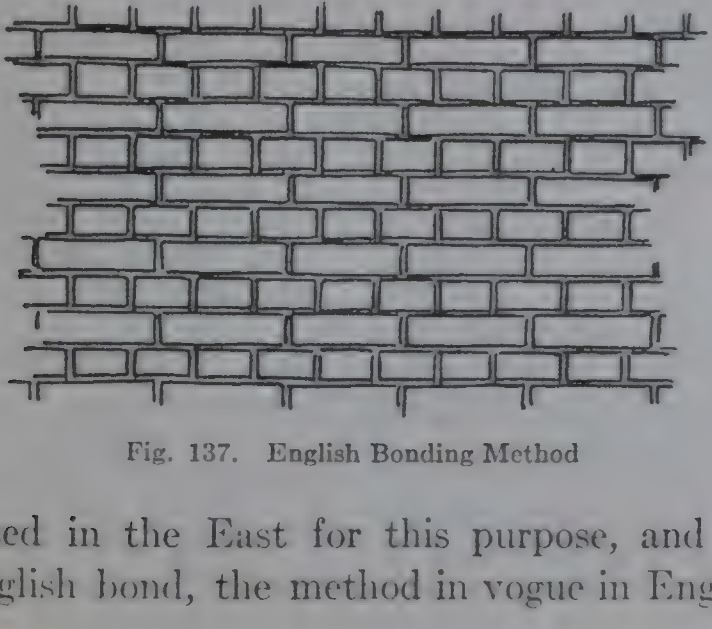


Fig. 137. English Bonding Method

of alternate courses of headers and stretchers, Fig. 137. Flemish bond, Fig. 138, consists of alternate headers and stretchers in each course. This bond is sometimes employed effectively in facings of common brick by inserting blackened headers, and it is sometimes used for every fifth course of face work instead of the diagonal headers. The bonding of angles is an important matter, and, in addition to the regular bond, most city laws require that the corners shall be tied with iron straps or bolts. In joining new work to old, however, direct bonding should be avoided for fear of unequal settlement, and some such method as that shown in Fig. 139 should be adopted.

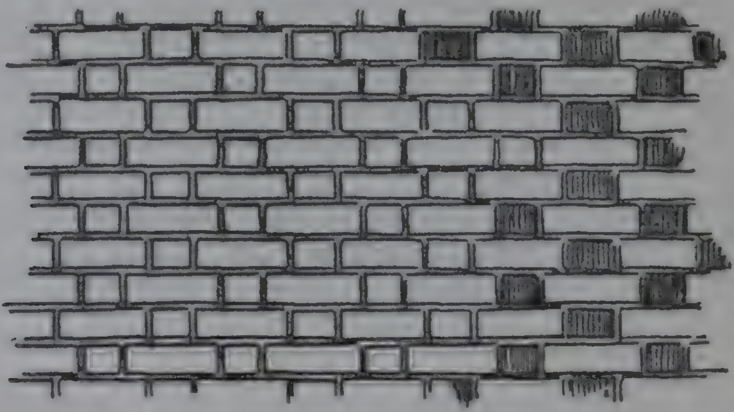


Fig. 138. Flemish Bonding Method

Construction in Freezing Weather. To obtain satisfactory results, bricks should never be laid in freezing weather. If the temperature is much below 40° F. during the day, so that it is likely to freeze during the night, salt may be mixed with the mortar and the top of the wall well covered with boards and straw; and if the upper courses are found to have frozen over night, they must be taken down and relaid, as the alternate freezing and thawing will materially damage the strength of lime mortar and will entirely ruin mortar made of natural cement of the Rosendale type. The following suggestions for the use of cement mortar have been given:

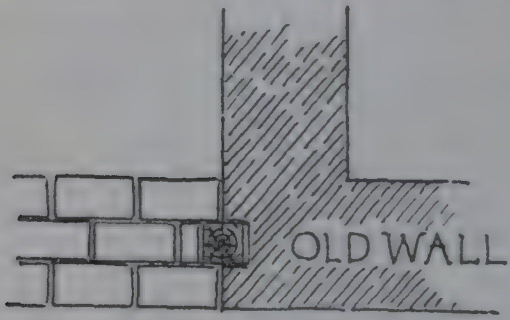


Fig. 139. Joint of New and Old Work

> Mortar made of one part of Portland cement and three parts of sand is entirely uninjured by freezing and thawing. If it is absolutely necessary that brickwork should be laid in freezing weather with natural cement mortar, it may be done by mixing the mortar with water to which salt has been added in the

proportion of 1 pound of salt to 18 gallons of water, when the temperature is at 32° F.; for each degree of temperature below 32, add 3 additional ounces of salt. Mortar mixed with such a solution does not freeze in ordinary winter weather, and hence is not injured by frost.

In addition to this, the bricks should be warmed to remove any ice or frost. These methods may be used in emergencies, but the laying of bricks in freezing weather is not to be recommended.

Thickness of Walls. No practical rule can be laid down for the thickness of brick walls, as their crushing strength, which is usually the only direct strain applied, is generally, except in the case of small piers, a minor consideration. In all large cities the minimum thickness is fixed by law, walls of mercantile buildings being heavier than the walls of buildings used for living purposes; in no case is it advisable that party walls should be less than 12 inches. Exterior walls for a building of five stories should be not less than 20 inches in the lower story and 12 inches in the upper story. These dimensions apply to stories of ordinary height with spans of not more than 25 feet, or more than 25 feet without a pier. Walls which contain 33 per cent of openings should also be made thicker.

In the case of bearing walls—those which carry besides their own weight the weight of floors and roofs which bear upon them—the thickness must be necessarily increased as the height of the building is increased, and they must be strong enough to brace the building against lateral forces, such as wind pressure, and the vibrations from external or internal sources.

Curtain walls—that is, those built between steel or iron columns. or between piers, which carry no loads except their own weight—have need of a thickness only such as to protect the outside of the building and give support to walls above.

In the case of skeleton construction, which has all its walls as well as other parts of the building supported by steel or iron columns, the masonry needs to be of just sufficient thickness to protect the building and the frame against the elements, unless these walls are depended upon for stiffening and bracing the building. The exterior walls may be of brick, concrete, terra cotta, or other fire-resisting material, depending in a measure upon the location, custom, experience of builders, and the influence of union labor in various localities.

The walls of each succeeding story in a skeleton frame will be supported independently and may be considered as curtain walls At the present standard prices of materials, a building for ordinary floor loads can be erected eight stories high with continuous bearing walls of masonry, more cheaply than with piers and curtain walls or skeleton construction. If, however, the extra land area which the thicker bearing walls require is of value enough, it will be economy to use skeleton construction for six-, or even five-story buildings, depending largely on the character and location of the building.

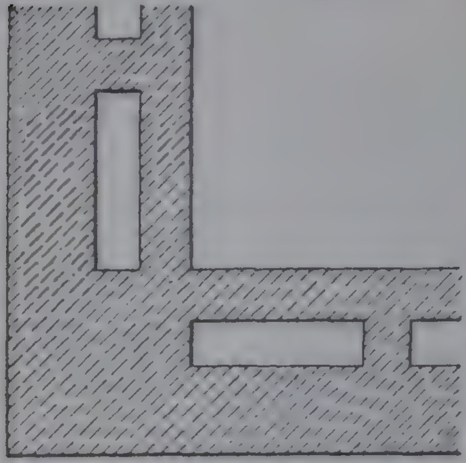


Fig. 140. Typical Hollow Wall with Brick Headers

Hollow Walls. To overcome the tendency of a solid brick wall to transmit heat, cold, and dampness, hollow walls are often constructed. A given number of bricks built as a hollow wall will make a more stable wall than will the same number of bricks built as a solid wall, and will gain besides the advantage of the air space. Nearly all building laws require the same amount of brickwork in hollow walls as in solid walls, independent of the air space, so that there is a loss of space which must be taken into account in city building.

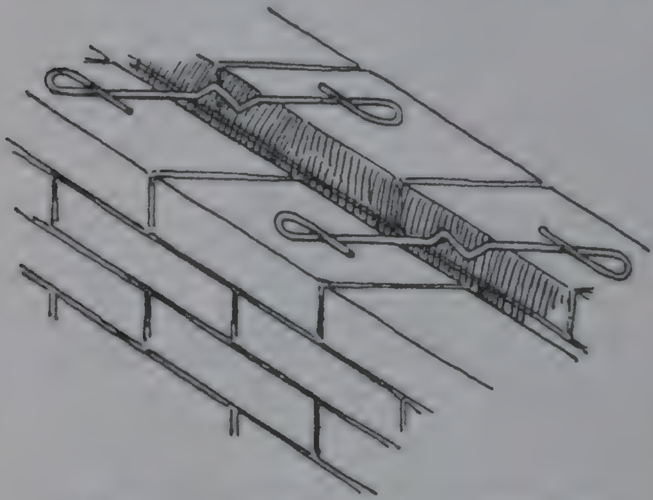


Fig. 141. Hollow Walls with Metal Ties

An important consideration is the bonding of the two portions of a hollow wall so that each will help to sustain the other. The usual method has been to do this by means of withes or headers of brick extending across the air space, Fig. 140, but these permit the moisture to pass from the outer to the inner shell, and also allow the mortar dropped from the higher portions of the wall to collect and partially fill the space. A more effective method of bonding is by means of a metal tie, either of steel wire or of iron, which should be made with a dip in the center to allow any moisture that may come from the outer wall to drop off without being communicated to the inner wall, Fig. 141. These ties should be either galvanized or dipped in hot asphalt. It is a good plan to provide for a circulation of air through the space between the walls, by leaving openings in the basement and in the attic where possible. Hollow bricks are sometimes used for the inside course of exterior walls, but while they are partially successful in excluding moisture they do not take the place of a hollow wall.

Veneered Walls. In some localities, dwellings and light mercantile and public buildings are built with a frame of studs and boarding, veneered on the outside with 4 inches of brick. In such construction the strength of the building lies in the frame, and the superintendent should see that this is built and braced in the best manner, with all material of well-seasoned stock. Over the boarding, tarred felting should be placed, and an inch away from this, the 4-inch wall, tied at short intervals to the wooden wall, as shown in Fig. 142. A metal tie such as at *A* may be used, or the patented tie *B*, which is better.

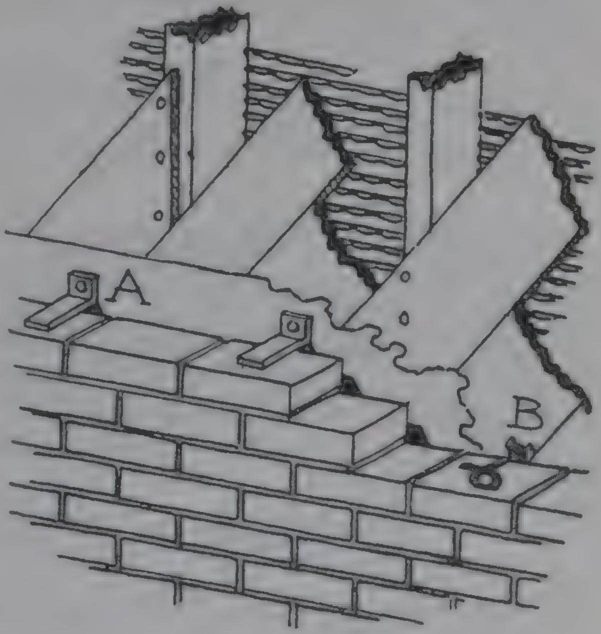


Fig. 142. Method of Bonding Brick Veneer

As moisture will collect in the air space behind the veneer, the ties will be better if given a drip, as for hollow walls, and a small drain may be laid at the top of the foundation wall, connected with the cellar by pipes for drip and ventilation.

Wood in Brick Walls to Be Generally Avoided. The combination of masonry and woodwork is not to be recommended in general, and should be used only as a matter of economy. Wood in the structure of brick walls may be sometimes necessary, but it should be avoided where possible. Wooden lintels were formerly used to a considerable extent, but they are objectionable for many reasons. Besides the fact that they are combustible, there is the difficulty of obtaining dry beams of the large size required, and the shrinkage is pretty sure to make a crack at some time, Fig. 143. Wooden plates should not be inserted in the wall for a level bearing of floor timbers, as their shrinkage will leave the bricks above unsupported. Wooden lintels may be used under arches to form a square opening, but the arch should always spring from the solid wall beyond the lintel in order to relieve the latter from the load above, Fig. 144. Wooden strips are sometimes built into the walls for a nailing for furring and finish, but they should be thin enough to lie in the joint; wooden bricks, often used for nailing, by their shrinkage will become loose, besides weakening the walls. A better way is to use a strong mortar into which the nails of the furring strips may be driven, or, in special work, to set in porous terra cotta blocks for nailings.

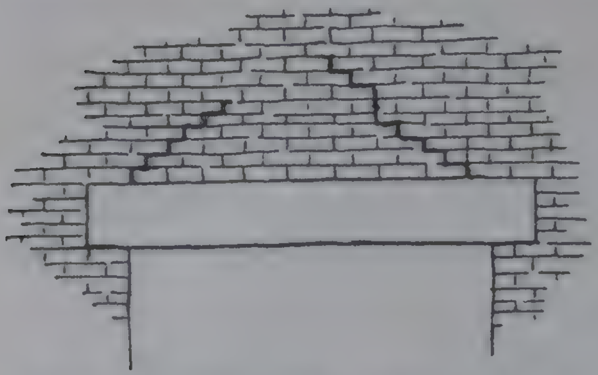


Fig. 143. Wood Lintels Usually Produce Cracks in Brick Walls

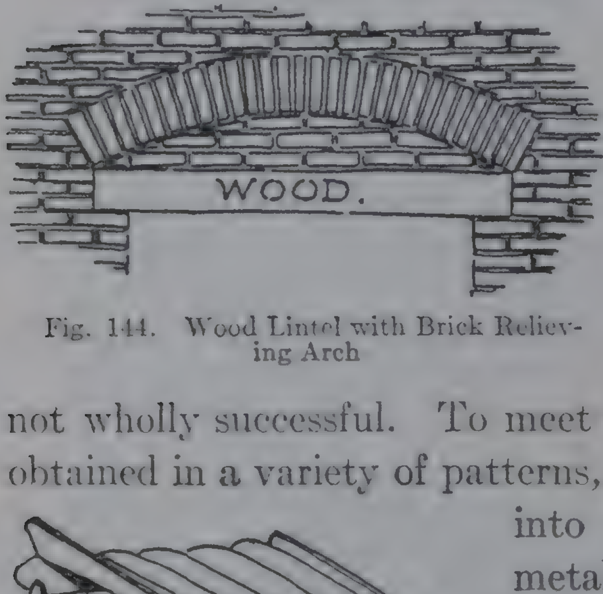


Fig. 144. Wood Lintel with Brick Relieving Arch

Wall Plugs and Inserts. For high buildings or walls subjected to heavy loads, the use of Portland cement for all kinds of masonry produces such hard mortar in the joints that the method of nailing the furring strip to brick or stone walls is not wholly successful. To meet this condition, metal plugs may be obtained in a variety of patterns, all designed to provide an orifice into which nails may be driven, the metal being corrugated or roughened in some way to grip the nail, Fig. 145.

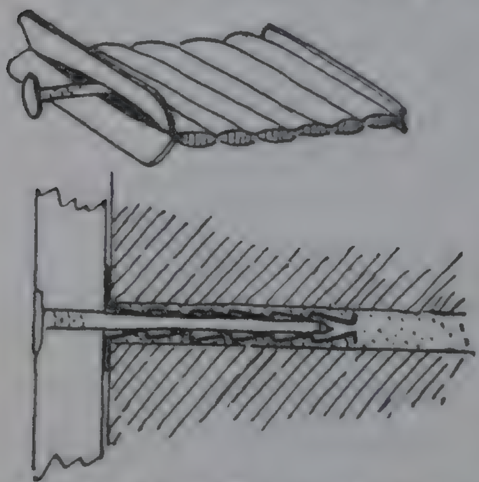


Fig. 145. Metal Wall Plug for Nailing in Brickwork

Of a similar nature are the different sorts of inserts placed in the concrete to receive the bolts or screws which may be necessary in the construction. These inserts consist of sockets or spiral members which are fastened in position to the forms before the concrete is poured.

The superintendent should carefully examine and verify the position of both plugs and inserts, as faulty alignment makes the plug or insert worse than useless.

Arches. In the erection of brick walls, special care should be given to the construction of arches which are necessary to span the openings. Arches should, in general, be laid in cement mortar. The two principal forms of arches in brickwork are the *rowlock arch*, where the bricks are laid in concentric rings of headers, Fig. 146, and the *gaged arch*, where the bricks are cut and bonded on radial lines, Fig. 147. For arches of large spans the bricks are often laid in rings of stretchers, Fig. 148, and, if the span is very large, these may be strengthened by bonding in headers, as in Fig. 149. An important point in the use of arches is to see that each abutment contains sufficient masonry to support the thrust of the arch; tie rods should be freely used in case of any doubt, and the arches of large span should spring from stone skewbacks carefully cut to radial lines, Fig. 150.

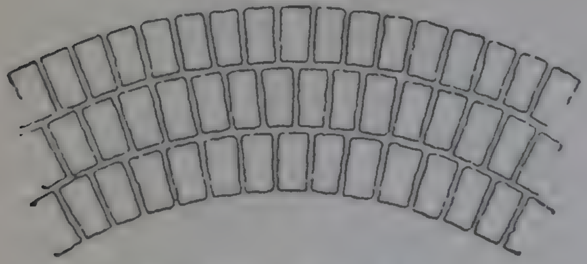


Fig. 146. Rowlock Arch

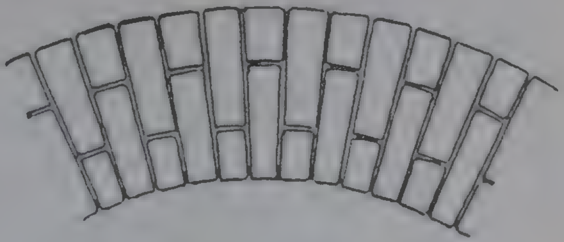


Fig. 147. Gaged Arch

Cleaning Walls. When a piece of brickwork is completed, the exterior needs to be cleaned of mortar stains and discolorations. This is done by applying a dilute solution of muriatic acid to the wall, using a scrubbing brush, and then washing with clear water to remove all traces of the acid. After this the wall is often given a coat of linseed oil cut with turpentine. At this time, also, all bad joints are pointed, the spaces under window sills are filled, the joints of the stonework pointed, and the wall left whole and clean.

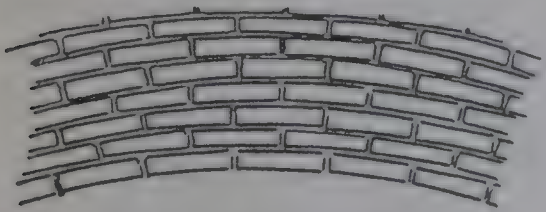


Fig. 148. Arch of Stretchers

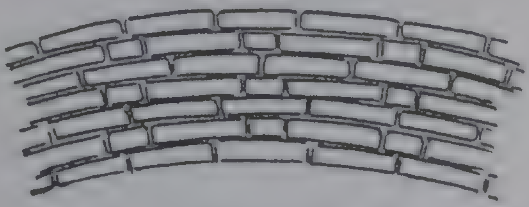


Fig. 149. Bonded Stretchers in Arch

Waterproofing Walls. Brick walls in exposed situations are often treated with some substance to render them waterproof. One of the most successful processes is known as the *Sylvester process*, and consists in applying two washes to the walls, one composed of Castile soap and water, and the other of alum and water. These applied alternately generally render the work impervious to moisture. Several patented solutions are now upon the market, each of which is warranted to furnish full protection.

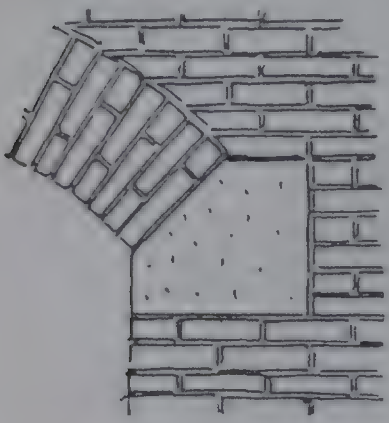


Fig. 150. Stone Skewback

Preventing Efflorescence. Very disagreeable and very common is the white efflorescence which often appears upon the face of the bricks, due to the salts of soda and potash dissolved by the water and left on the surface by evaporation. The Sylvester solution, applied in the same manner as for waterproofing, is a preventive of this, and the danger may be diminished by using stronger cement in the face joints.

Making Repairs. In making repairs in masonry, when new work is to be connected with old, the mortar of the old work must be entirely cleaned off along the surface where the junction is to be made, and the surface thoroughly wet. The bond and other construction details will depend upon circumstances. The surfaces connected should be fitted as accurately as practicable, so that by using but little mortar no disunion may take place from settling. As a rule, it is better that new work should butt against the old, either with a straight joint visible on the face, or let into a chase, sometimes called a "slip-joint", Fig. 151, so that the straight joint may not show; but if it is necessary to bond them together, the new work should be built in a quick-setting cement mortar, and each part of it allowed to set before being loaded. In pointing old masonry, all the decayed mortar must be completely raked out with a hooked iron point and the surfaces well wet before the fresh mortar is applied. The lining of old walls should be not less than 8 inches thick and should be anchored every 2 feet.

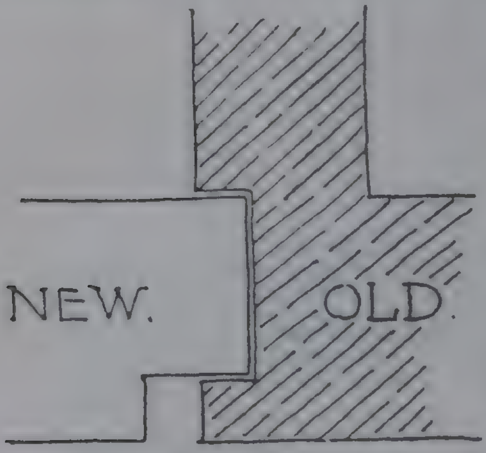


Fig. 151. Slip Joint

Brickwork for City Dwellings. The classification of city dwellings covers both those joined to each other in rows and, in outlying districts, those built as separate houses having each its surrounding grounds of greater or less size. The detached houses of the city stand between the typical country house and the grouped city mansions, and even though situated beyond the city limits where fire-resisting construction is required, it will usually pay to build them of masonry for the sake of durability as well as fitness, and it is to brick, stone, or cement, that we turn for the exterior treatment outside as well as inside the city limits.

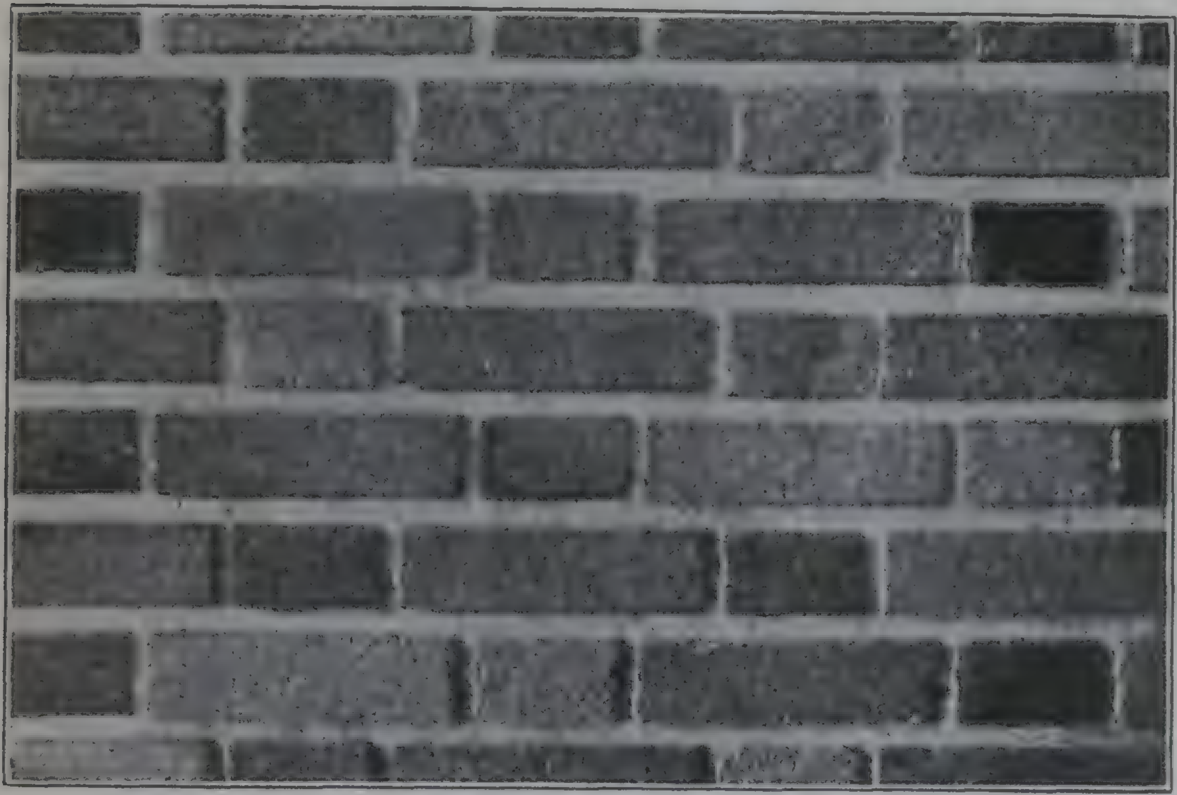


Fig. 152. Typical Wall of Tapestry Brick

While common bricks as well as face bricks are suitable and customary for city dwellings, there has been developed a kind of brick particularly pleasing in texture and colors called "tapestry brick", as shown in Fig. 152. These are made in many shades of soft coloring; the bricks are extremely rough in texture, but when laid with heavy deep joints in a pleasing bond they give an excellent effect.

In using bricks for the exterior walls of a dwelling, it should be remembered that they do not make a wall which is wholly impervious to moisture; it is necessary, therefore, to take some precaution to protect the inside plastering of the walls against dampness which might work through, however thick and well the wall may be built, and which would injure the tinting or papering, even though it did not loosen the plaster. This protection is commonly secured by furring the lathing off from the wall at least an inch, either by means of wooden strips or by a metal furring which comes attached to metal lathing for this purpose. Wooden strips are generally used, and when wooden laths are applied, the air space thus formed, running from bottom to top of each story, should be cut off at each floor at least, to prevent fire from spreading from story to story. In addition to this space it is well in many cases to apply a waterproofing compound to the back of the wall if the bricks are not very hard burned.

A better method of furring and one with greater fire resistance, consists in using thin terra cotta blocks secured to the back of the wall, to which the plastering may be directly applied. This does away with all wooden strips, except those necessary to provide nailings for the wood finish, and while more expensive, it is to be recommended for first-class work.

Supervision. In superintending brickwork, the main things to be observed have been pointed out in connection with the construction. Especial care should be taken to see that the bricks are properly wet, that sufficient mortar of the right quality is used, and that the joints are thoroughly filled. The bonding of the wall must be constantly noticed, especially that of facework and piers. The work should be measured from time to time and the position of all openings noted. Reveals and jambs should be measured and plumbed and the leveling of courses carefully observed. At the level of the floors the bedding of all bearing plates must be watched and the number and position of floor and wall anchors noticed. Recesses and flues should be carefully followed out, and the tying together of hollow walls must be frequent and effective. When work is stopped, the top of the wall should be covered, no matter in what season the work is being done—in summer to prevent rain from washing out the soft mortar, in winter to keep the water from entering and freezing. To obtain the best results, the laying of brick walls should not be attempted in freezing weather.

CUT STONEWORK

SELECTION OF STONE

First in consideration of the superintendence of stonework is the preparation of the material. In former times, for a work of importance, the stone was often brought to the building site in the rough, and all stone-cutting was done on the spot, but nowadays the stone is prepared at a stoneyard, often by machinery, and is ready to be set when received. The stone should be carefully examined *when delivered*, and not allowed to accumulate in great quantities without inspection, as a thorough examination is then more difficult. According to the nature of the work, the stone will have received more or less preparation by being worked into the various shapes and finishes suited for its purpose.

Varieties of Stone. The principal building stones in use in this country are granite, limestone, marble, and sandstone, and choice among these for a given building will be made with reference to color, durability, and strength. Probably the question of color will enter more into the selection than any other consideration, but this should not wholly overshadow the considerations of strength and durability. Cheapness and accessibility are highly important factors, and in cities resistance to atmospheric action and especially to fire, may well be taken into account. While no building stone will resist the action of fire for any length of time, of the different kinds of stone mentioned, fine-grained sandstone will probably withstand fire the best, granite next, and marble and limestone the least.

Testing Stone. Although it is possible in most cases to obtain stone for a building from some well-known quarry, the qualities of which have been sufficiently proved, occasion may arise when some simple test of a certain stone may be desirable. These tests should be made for compactness, absorption, strength, and fracture. The compactness of a stone can be best determined by comparison with some known stone of similar constituents, the less porous in appearance proving usually the more durable. The porosity may be determined by the power of absorption which the stone exerts. This may be found by immersing the thoroughly dried stone in water, and noting the difference in weight between the dry and the wet stone. The absorption of 10 per cent of its weight denotes a degree of porosity which is likely to give the stone, after a time, a grimy appearance, while a hard nonabsorbent stone suffers little from age.

In situations where the atmosphere is charged with acids, as in large cities or manufacturing towns, there will be danger from the solubility of the stone, especially in damp climates. Too great a tendency to solubility may be discovered by soaking the stone in a dilute solution of acid, or by dropping acid upon the surface, when the presence of soluble carbonates will be denoted by an effervescence. The presence of substances easily soluble in water may be detected by placing some of the powdered stone in a glass with water and allowing the particles to settle. If the water is later disturbed, the presence of soluble matter will cause the water to turn muddy; if the water remains clear, the presence of only insoluble crystals is denoted.

FINISHING OF STONE

The method of finishing a stone has a great effect, not only upon its appearance, but upon its durability. The less pounding a stone receives the stronger it will be, since the repeated jar tends to separate the particles and so to impair the durability of the stone. For this reason it is only granite and hard sandstones that are usually treated by hammering the surface, the softer stones being generally finished by the use of some form of chisel.

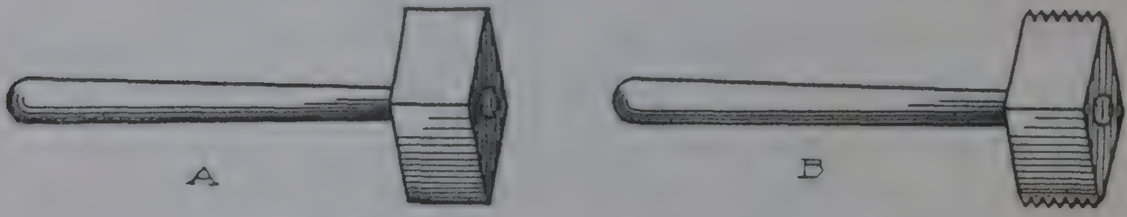


Fig. 153. Stone Axes. *A*—Solid Edge; *B*—Tooth Edge

Tools. The principal tools used in stone-cutting are the following:

Axe or *peen hammer*—a solid tool with two cutting edges, used for making the draft line or margin on granite, and in leveling off the face, Fig. 153-*A*.

Tooth axe—similar to the axe, except that the cutting edges are divided into teeth. This is used on sandstones as well as on granite, Fig. 153-*B*.

Bush-hammer—a square head cut into a number of points and used for finishing sandstone and granite, Fig. 154-*A*.

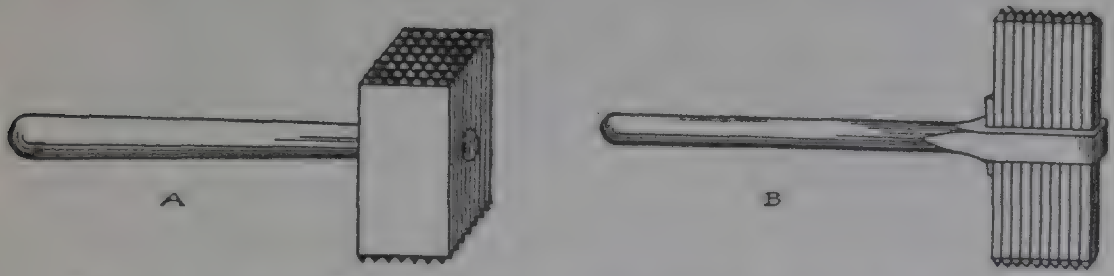


Fig. 154. *A*—Bush-Hammer for Finishing Stone and Granite; *B*—Crandall Used for Finishing Sandstone

Crandall—an iron handle with a long slot at one end into which are wedged a number of double-headed points. These points are secured by a key and may be removed for sharpening. This is a common way of finishing sandstone after the surface has been leveled by means of a tooth chisel, Fig. 154-*B*.

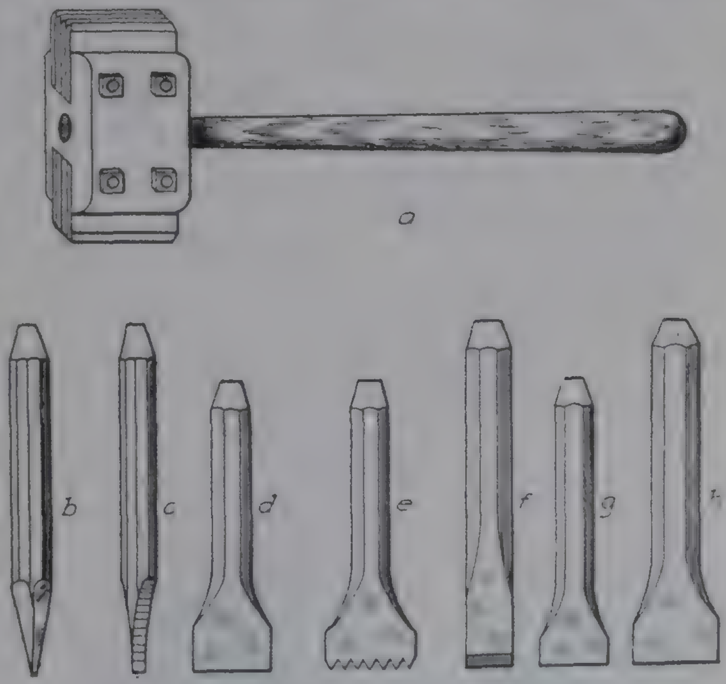


Fig. 155. Patent Hammer and Various Forms of Chisels

Patent hammer—this consists of a number of thin blades of steel which are bolted into a heavy head and is used for finishing granite and hard sandstones, Fig. 155-*a*.

Chisels—various forms, among which are to be found the point *b*, Fig. 155, chisel and drove *c* and *d*, the tooth chisel *c*, all for use with a mallet; the hammer chisel *f*, and pitching tools *g* and *h*.

Finishes. The simplest of the various finishes which are given to cut stone is the *rock face*, shown in Fig. 156. In this, the face of the stone is left rough, the edges being pitched off to a line. A margin or draft line is often cut around the edge, leaving the center with rock face, Fig. 157. *Pointed work*, Fig. 158, is done by taking off the surface of the stone with a point, and is made rough or fine pointed according to the position or importance of the stone. This is used mainly for granite, a similar effect being obtained in soft stones by the use of the tooth chisel. *Tooled work*, Fig. 159, is done in straight lines clear across the face of the stone and is used a great deal for sandstone and limestone.

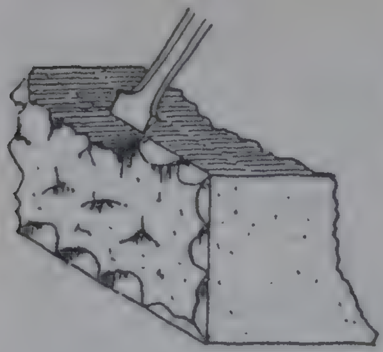


Fig. 156. Pitching Off for Rock Face

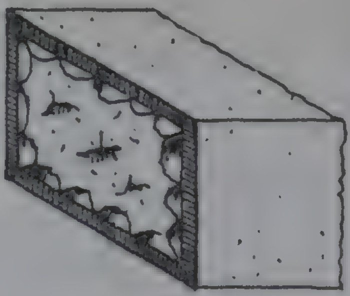


Fig. 157. Rock Face with Draft Line

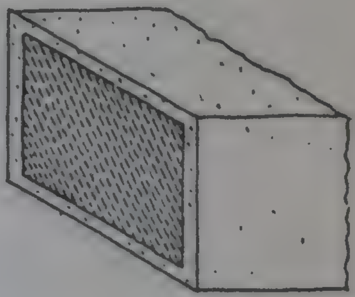


Fig. 158. Pointed Work

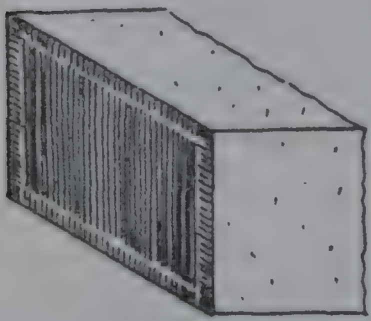


Fig. 159. Tooled Work

Bush-hammering, as its name implies, consists in hammering the stone, usually granite, with a bush-hammer, leaving the surface covered with points. *Patent hammered work*, Fig. 160, leaves the surface covered with a series of ridges. It is known as "six-cut", "eight-cut", or "ten-cut" work, according to the number of points to the inch. This is the customary finish for granite and generally eight-cut work is called for. *Crandalled work*, Fig. 161, is used for sandstone more than any other finish, and consists of a series of lines either crossing each other or running all one way, according to whether

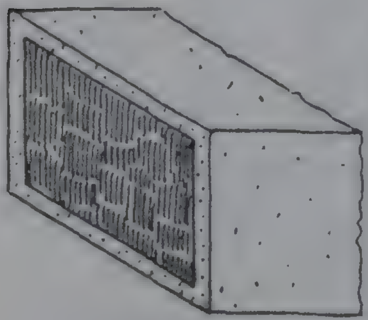


Fig. 160. Patent Hammered Work

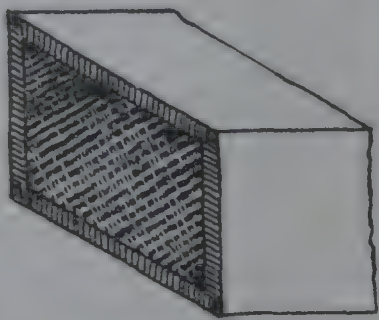


Fig. 161. Crandalled Work

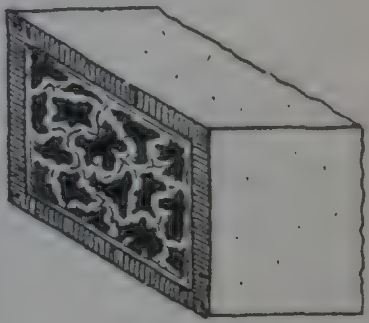


Fig. 162. Vermiculated Work

the crandall is used from one side or from both. If a smooth finish is desired the stones may be rubbed. This is easily and cheaply done when the stone is first sawed, and makes a good finish. *Vermiculated work*, shown in Fig. 162, is obtained by working the whole surface over in imitation of the destruction by worms. This is expensive and is rarely used except for quoins.

Supervision. The inspection of stone at the building should be very thorough, especially in the matter of finish. The finer the degree of finish the more costly is the labor, and for this reason there is often a tendency to slight the work. Eight-cut granite will often be found to be six-cut, and fine pointed or fine crandalled work will sometimes be found to be rough and coarse.

STONE MASONRY

Rubble. Of the different kinds of stonework, rubble masonry requires the least preparation of the material. It is used for many sorts of construction, from ordinary foundation walls, such as we have already considered, to the handsome well-pointed masonry of churches and other buildings.

Types. Two definite classes of rubble work are recognized: (1) *uncoursed rubble*, in which stones of irregular shape are laid as they come to hand with no attempt at level courses, Fig. 163; and (2) *coursed rubble*, in which the blocks are leveled off at regular heights to a horizontal bed, Fig. 164. A wall of rubble is finished by pointing up the joints with cement mortar, colored as preferred, but usually matching the stone when that is at all even toned. Sometimes a false joint of red or white mortar is run upon this pointing to imitate ashlar work.

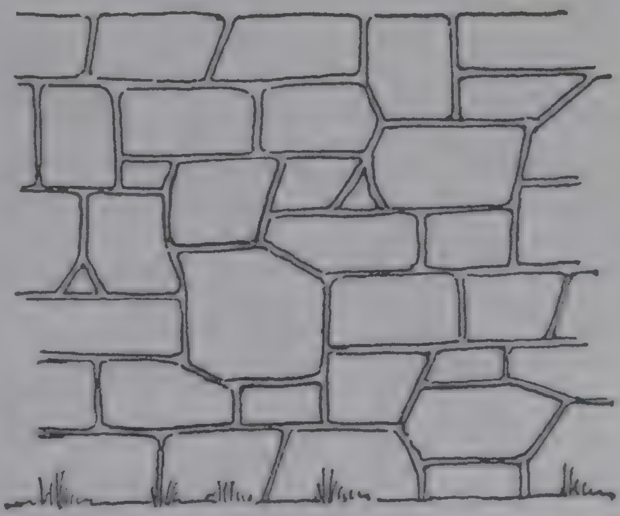


Fig. 163. Uncoursed Rubble

Uncoursed rubble in some cases is laid with the pieces having hammered joints which are fitted together with no spalls, or small stones, between, Fig. 165. This is an expensive and tedious process but is very effective when well done. The coursing of rubble is not necessarily uniform, or at the same level throughout, but may rise and fall by level stages to accommodate the size of the materials.

Laying Stone. The superintendence of this class of work, beyond a general inspection of the quality and soundness of the stone, involves mainly seeing that the stones are well laid after they have been suitably prepared by roughly squaring them with a hammer, and knocking off all weak angles and projections. The stones should be clean and free from dust, and should be moistened before being laid. Mortar must be used in sufficient quantities to permit each stone to be firmly placed, and all hollows between the large stones should be filled with small stones carefully bedded in the mortar. The large stones should be laid on their natural bed, and should be so used that the side parallel to the bed will be the largest, so that the stones will lie flat and in no case be set on edge or on end. Care must be taken to break joints, and no side joint should form an angle with the bed of less than 60 degrees.

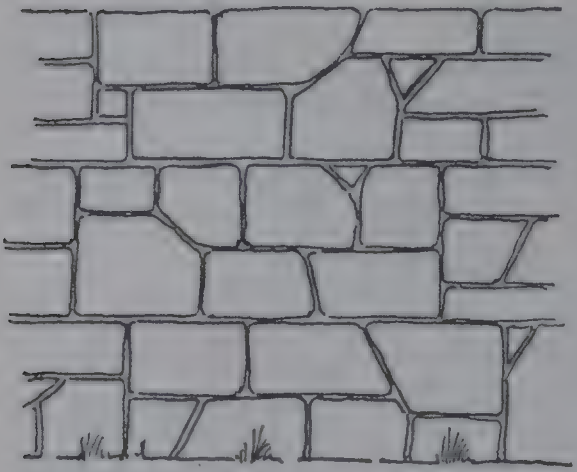


Fig. 164. Coursed Rubble

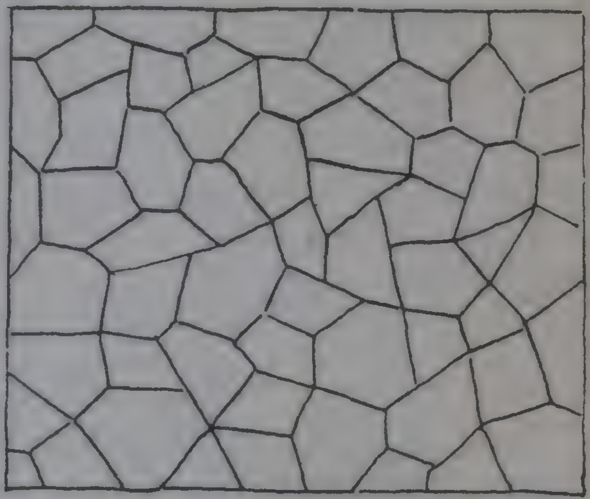


Fig. 165. Hammered Joints with no "Spalls"

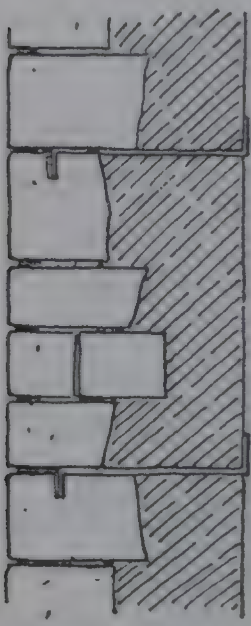


Fig. 166. Stone Wall Facing with Iron Ties

Bonding Stone. The bonding of a rubble wall must be carefully watched. Bond stones must be freely used. If the rubble is backed with brick, as is often the case, iron clamps and ties should be inserted, which may run through the wall and turn up behind the brick if the back of the wall is to be concealed, and which should run to the inside course of bricks in any case, Fig. 166. If rubble is used as a backing for cut stone, the facing should contain a large proportion of thick stones which will bond well with the rubble. These bond stones may be left rough at the back and sides, but the upper and lower beds should be level, so that the stones will have no tendency to wedge off the backing. The backing should be carried up at the same time as the facework, with the coursing leveled off at the same place. A good proportion of thick stones running two-thirds or more across the thickness of the wall is better than a few extending through the wall.

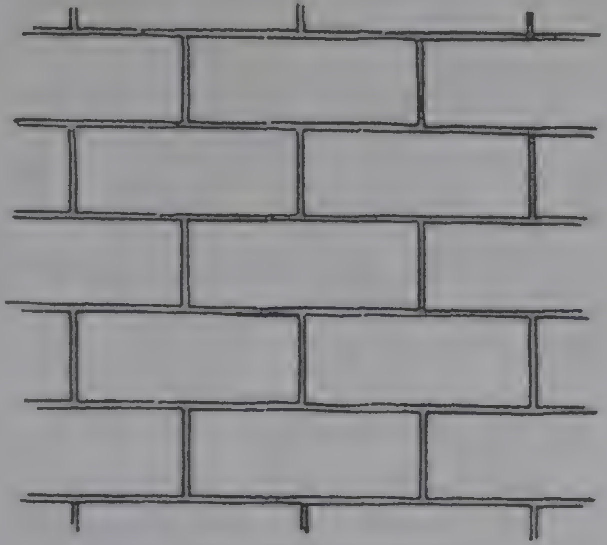


Fig. 167. Ashlar Masonry

Ashlar. Ashlar masonry consists of blocks of stone which have been cut to a regular figure, generally rectangular in shape, and laid in courses usually a foot or more in height, Fig. 167. If the courses are not maintained at the same level continuously, but are laid of stones of unequal height which are, however, still level and plumb, the work is called *broken ashlar*, Fig. 168.

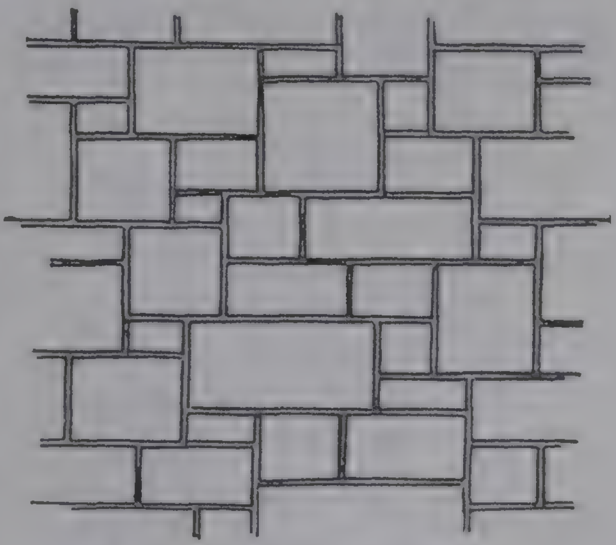


Fig. 168. Broken Ashlar Masonry

In all ashlar work with soft material, such as limestone, no stone should have a length greater than three times its height. In harder stone the length may be four or five times the height. The thickness in soft stone may be once and one-half or twice the height; in hard stone, three times the height.

Laying Stone. The bed upon which the stones are laid should be level, cleared of dust or refuse, and well moistened with water. Upon this the mortar is spread evenly. Wooden wedges of the thickness of the joint are then laid on the face of the bed, and the stone carefully lowered upon them, to be moved into exact position by the aid of a pinch bar. In using a bar or rollers to handle cut stone, it will be necessary to protect the edges of the stone by bagging or other "softening". When the stone is in its final position, the wedges may be removed and the stone settled into place and leveled by striking with a wooden mallet. In the case of heavy stones, where there would be danger of the weight of the stone squeezing the mortar out of the joint, the wooden wedges are allowed to remain until the mortar has set.

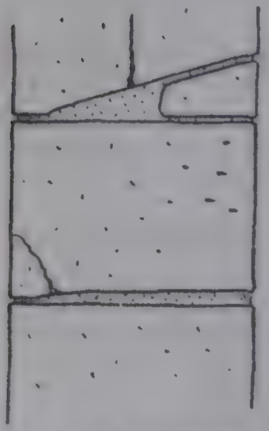


Fig. 169. Bad Effects of Hollow and Slack Joints

The bed of mortar should be kept back an inch or so from the face of the stone, so that the stone will not bear on its outer edge. This will save raking out the mortar when the wall is to be pointed, and will prevent any danger of the splitting-off of spalls on the face, which might occur on account of the mortar on the face of the joint becoming hard sooner than the inside, and the unequal settlement bringing pressure on the edge of the stone. The same mishap may occur if the bed of the stone is cut hollow or slack, as in Fig. 169, when the settlement of the mortar will bring the whole pressure upon the front edge of the stone. For this reason, care should be taken that the bed joints are square and true.

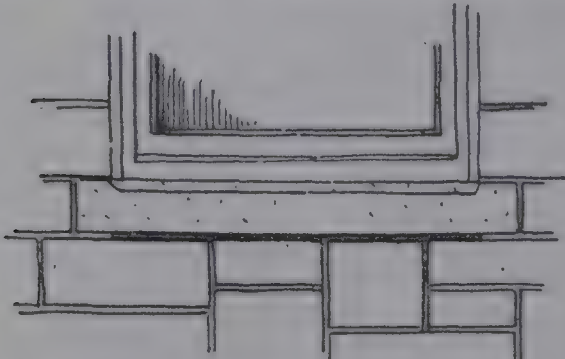


Fig. 170. Proper Bedding for Window Sill

Door and window sills should be bedded only under their ends, as the natural settlement would cause them to break if bedded under the opening, Fig. 170. Stone work in damp situations should be set in cement mortar, but lime may be used if the situation is dry. Limestone and marble, and some sandstones, are often badly stained by the use of cement mortar, and inquiry in respect to this should always be made before using an unfamiliar stone. In case of danger of staining, Lafarge cement, made of lime, plaster of Paris, and marble dust, may be used; it should be plastered over the back of the stone as well, if cement must be used in the backing.

Bonding Stone. Care must be taken that no vertical joint in any course comes over a joint in the course below; the stones should break joints or overlap, preferably to an extent of from once to once and a half the height of the course, so that each stone will be supported by at least two stones of the course below, and will in its turn support at least two stones of the course above. This will not only distribute the pressure of the weight above, but will tie the wall together in its length by means of the friction of the stones where they overlap. The thickness of the stones should also vary so as to make a bond in and out of the wall, Fig. 171, and at least one stone in every ten square feet of wall should be the full thickness of the wall. The strongest bond in a wall of cut ashlar is one in which each course contains a header and stretcher alternately, the outer end of each header coming at the middle of the stretcher above and below, Fig. 172.

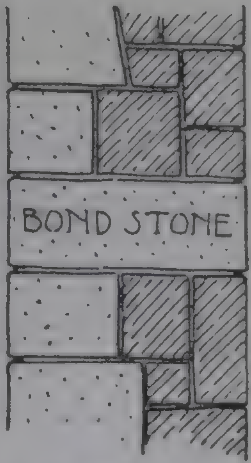


Fig. 171.
Bonding Stone

In broken ashlar work, the bond should be carefully preserved, and if there is a brick backing it will be convenient to use stones of a thickness of 4, 8, and 12 inches, alternating so that the bond may be obtained through and through without much cutting of the bricks. As the joints of the brick backing will necessarily be more numerous than the joints of the ashlar facing, the former should be made as thin as possible, and cement should be used to prevent their shrinkage. The backing should not be less than 8 inches thick. If the facing is in courses exceeding a foot in height, each large piece should be tied to the brick by iron clamps, placed about every three feet in the length of the wall and every two feet in the height. It will be of advantage in this class of work if the horizontal joints are not allowed to run to a great length. Changing the level of the courses every four or five feet will make a good looking wall. Broken ashlar is usually prepared at the building site, but it is a saving if the stones are cut to the required heights in the yard, only the end joints being cut at the building.

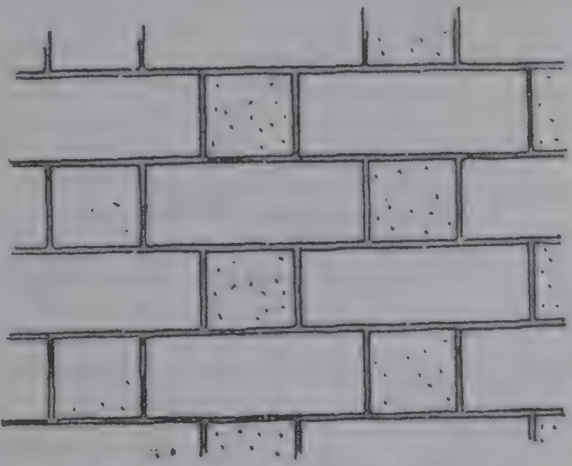


Fig. 172. Bonded Ashlar Masonry

Cast Stone. An increasing use is being made of cast stone or concrete stone, a manufactured product of a rather fine aggregate of crushed stone and Portland cement. This is molded in forms, machine or hand tooled, and may be cut to detail and set in the building in the same manner as natural quarried stone. A variety of effects of texture and color may be obtained by different aggregates and tooling. The natural quarried limestone, sandstone, or granites may be closely imitated, or the material itself may be given a special character by mechanical treatment, to vary the surface or expose the aggregate.

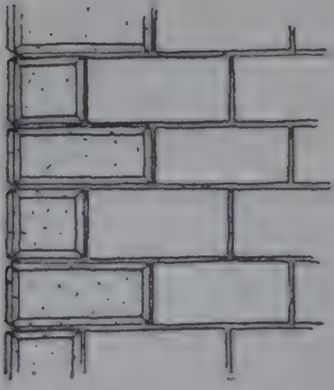


Fig. 173. Corner of Masonry Wall Showing Quoins

In the case of lintels or other members which support a tensile strain, steel rods or bars are added as reinforcement. The reinforcement permits the use of the cast stone for upright members when delicacy as well as strength is essential, as in shafts, pedestals, and other ornamental pieces, and it is used to a great extent for fountains, urns, reliefs, and sculptured or molded forms.

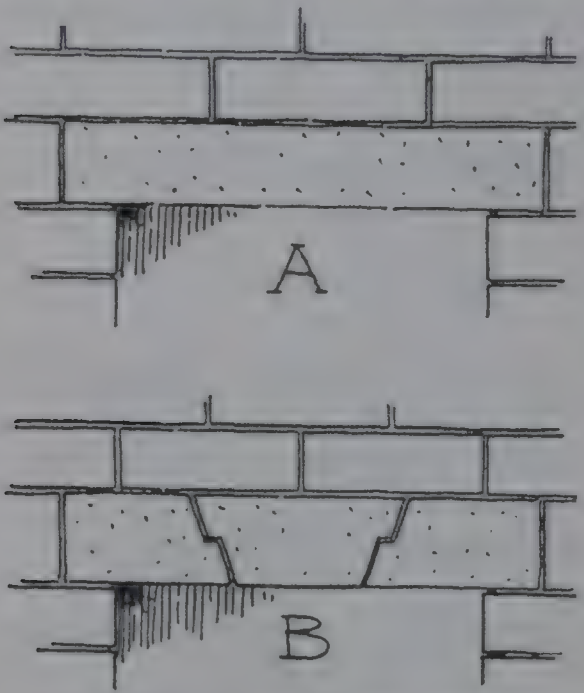


Fig. 174. Typical Stone Lintels

Quoins, Jambs, and Lintels. The corner stones of a building are called quoins and they are often given prominence over the face of the wall, Fig. 173. In broken ashlar the quoins should be of as great height as the largest of the wall stones. Stones at the sides of openings are called jambs and are often used in a manner similar to quoins.

Lintels or caps are the stones which cover door or window openings. They are usually in one piece, Fig. 174-*A*, but are sometimes necessarily jointed, Fig. 174-*B*. In the latter case the joints should be "toggled", as shown. If the lintel spans an opening which is too great for its carrying capacity, it may be assisted by the use of a steel angle bar or beam, Fig. 175. Lintels should bear at the ends at least 4 inches, and if the lintel is thicker than the jamb, it should have bearing enough to reach beyond any recess which the window frame may require, Fig. 176, so that the inside of the lintel will be supported.

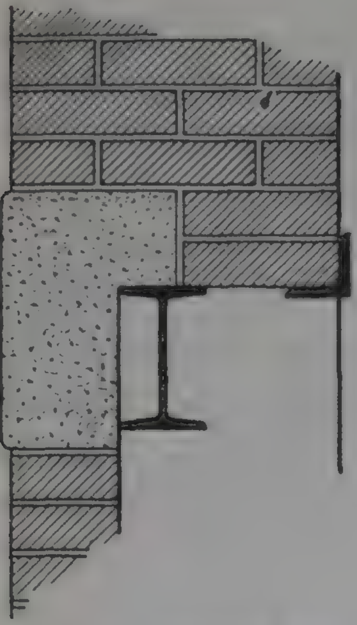


Fig. 175. Section Showing Steel Support of Lintels

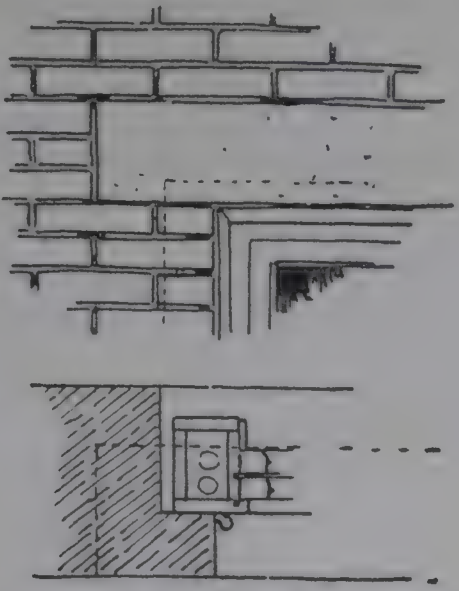


Fig. 176. Elevation and Plan Showing Bearing of Stone Lintels

Columns. Columns should be cut in one piece where the material will allow, with separate capitals and bases, and great care must be taken in cutting, and also in setting, to have the bed joints at right angles to the axis of the column. Clear cement mortar should be used for setting, and, to prevent chipping the column, attention must be given to keeping the outside of the joint empty

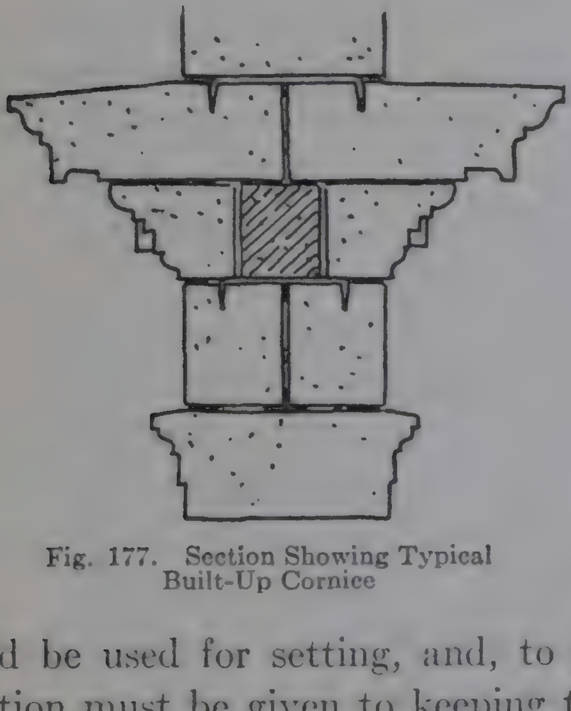


Fig. 177. Section Showing Typical Built-Up Cornice

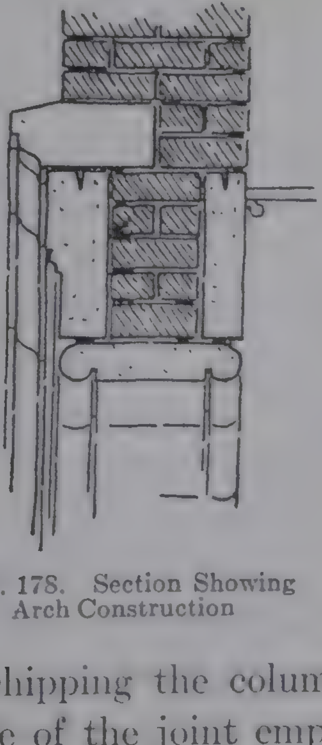


Fig. 178. Section Showing Arch Construction

for a depth of at least three-quarters of an inch. Lintels or cornices over columns are often exposed on both sides and should be cut from one stone, if practicable; if not, they may be built up as shown in Fig. 177, the stones being very carefully tied and clamped together.

Arches. Arches, if too large to be of solid stone, may be built up where both sides are to show, Fig. 178. In the setting of stone arches great care is necessary to preserve the perfect form of the arch. The joints should always be of equal thickness throughout and the mortar kept back from the face. This is of greater necessity than in the horizontal courses, as the joints of the arch are under increased pressure. The backing should be laid in cement, and well tied to the stones of the arch by clamps. Where two arches come together, the first stone, called the skewback, should be in one piece for the two arches, Fig. 179, for if each stone were cut to the shape of its arch there would be left a small wedge-shaped stone, *A*, which might crowd the arch stones in. Where an arch comes near to a corner, as at *B*, the skewback and the corner stone should also be in one piece.

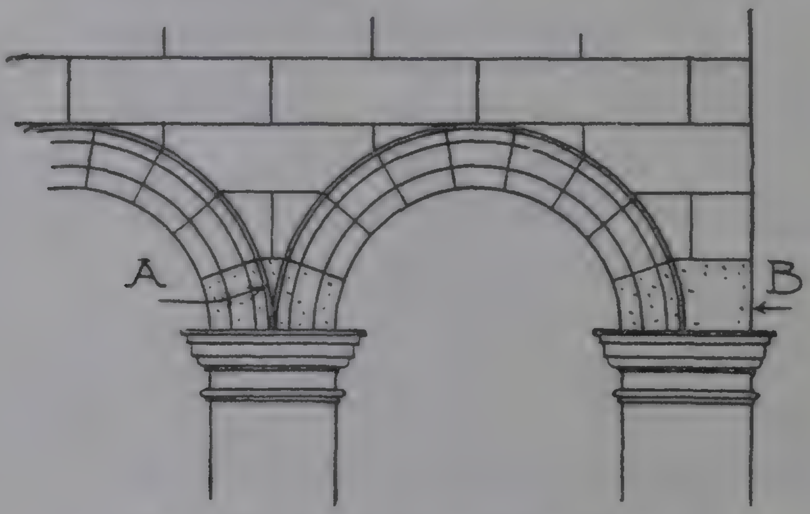


Fig. 179. Arches with Solid Skewbacks

Flat arches are often used, but, while they are architecturally pleasing, they are liable to constructional weakness, and if they cannot be given a good height, they should be cut as a lintel with false joints on the face. If the opening is not wide, a flat arch may be cut in three pieces, the key with its side pieces being separate from the other two pieces, Fig. 180. In this case, and also in the case of *B* in Fig. 174, the center should be set about one quarter-inch higher than the jambs, to allow for settlement.

Centering of Arches. For the construction of arches, whether of stone or other material, wood centers are required. These should be strongly made and left in position until the mortar in the joints has become hard. Centers for small arches are usually made of plank, with two ribs set apart to the thickness required, and connected for a bearing surface by strips of $\frac{7}{8}$-×2-inch stick nailed to the tops of the ribs. A center of this sort is supported by wooden posts from the sill or floor below. If the arch is of a large span, the number of pieces must be greater, in order to use planks of ordinary width, and the center will need additional support and ties, as shown by Fig. 181. These centers should be wedged up in setting, to allow easy adjustment or removal.

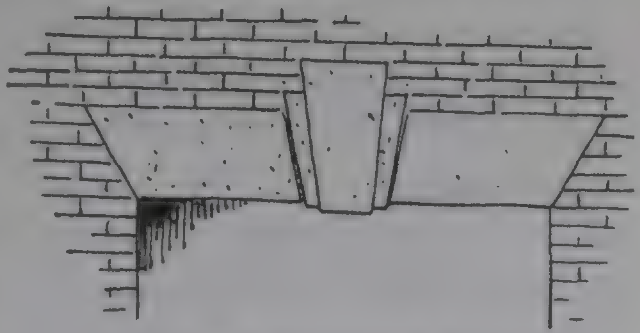


Fig. 180. Flat Arch of Stone

General Rules for Laying Stone. The following rules for the laying of stone are, in general, applicable to all work:

1. Build the masonry, as far as possible, in a series of courses, perpendicular, or as nearly so as they can be made, to the direction of the pressure which the stones must bear, and by breaking joints, avoid all long continuous joints parallel to that pressure.

2. Use the largest stones for the foundation course.

3. Set all stones which consist of layers in such a manner that the principal pressure which they have to bear shall act in a direction perpendicular, or as nearly so as possible, to the direction of the layers. This is called "laying the stone on its natural bed", and is of primary importance for strength and durability.

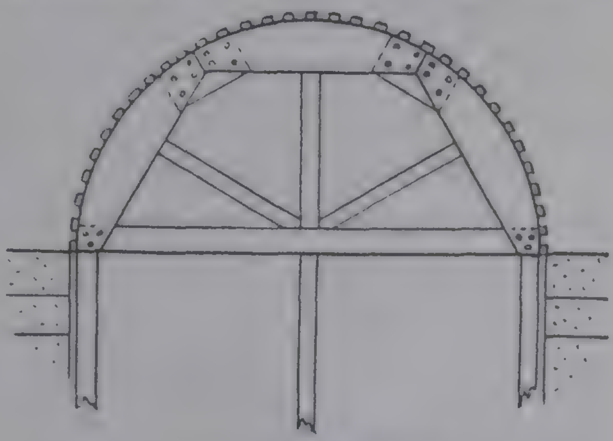


Fig. 181. Typical Wood Centering for Arch

4. Moisten the surface of dry and porous stones before bedding them, in order that the mortar may not be dried too fast and reduced to powder by the stone absorbing its moisture.

5. Fill every part of every joint, and all spaces between the stones, with mortar, taking care at the same time that such spaces shall be as small as possible.

6. The rougher the stones, the better the mortar should be. The principal object of the mortar is to equalize the pressure, and the more nearly the stones are dressed to closely fitting surfaces, the less important is the mortar. Not infrequently this rule is exactly reversed, i.e., the finer the dressing, the better the quality of the mortar used.

7. All projecting courses, such as sills and lintels, should be covered as the work progresses with boards, bagging, etc., to protect them from injury and mortar stains. When setting cut stone, a pailful of clean water should be kept at hand, and when any fresh mortar comes in contact with the face of the work it should be immediately washed off.

Pointing. When the exterior masonry of the building is completed, the whole of the stonework must be washed down and pointed. This should never be done in freezing weather, and if done in extremely hot weather there will be danger of the mortar drying too quickly. For ordinary stonework, Portland cement combined with an equal quantity of sand and enough water to make a stiff mixture, makes a good pointing mortar; but for limestone, marble, or any stone which would be stained by cement, lime mortar, Lafarge, or other non-staining cement must be used. If the joints are not already clean, they must be raked out to the depth of an inch and moistened, and the pointing mortar applied with a small pointing trowel and then rubbed in smooth with a jointing tool. Either a concave, flush, or projecting joint may be made, but the concave joint is more durable than the others. The washing-down of the stonework will be done at the same time as the pointing, and this should be done similarly to the finishing of brickwork, with dilute muriatic acid applied with a stiff scrubbing brush. Wire brushes are sometimes used to clean down marble and granite work.

Pointing is in some localities made a distinct branch of the building trade, and in others it is part of the mason's work. When possible, a professional pointer should be obtained, as he will usually have better appliances, ready for immediate use, than will the mason, whose use for them will naturally be occasional.

Supervision. The superintendence of cut stonework means constant attention, as it is expensive and annoying to be obliged to remove a stone after it has been set in the wall. There are, moreover, many devices by which defective stock and workmanship can be concealed, and these can be detected only by diligence and the exercise of considerable knowledge of practices.

The first thing necessary is a thorough inspection of the stone as delivered, and a careful search for defects which the superintendent knows are likely to occur in the various kinds of stone. Granite often develops local defects, such as seams, knots, or brown stains, known as sap. Stains will be apparent upon examination, but seams are to be detected by striking the stone with a hammer, when a flawless stone will ring clearly.

Sandstones are often found with small holes, called sand holes, and may be of an uneven color; there may also be local discolorations, which are sometimes developed by cutting and do not appear until so much expense has been put upon the stone that the contractor is often tempted to pass it as perfect if he can do so. Considerable firmness may be necessary to obtain work in exact conformity with the specifications, but this should be insisted upon at all times. Another defect which requires the exercise of great judgment is the matter of patched stones. Expensive stones are often marred by the cutting or handling, and are then so skilfully patched by the use of melted shellac and stone dust, that they may be overlooked until set, when they often cannot be replaced without considerable delay. In this case, if the owner agrees, they may be allowed to remain, but the superintendent should make sure that the patching is properly done. If a molding has been knocked off and simply stuck on again with shellac, the superintendent should insist that a square block be dovetailed in and the molding re-cut.

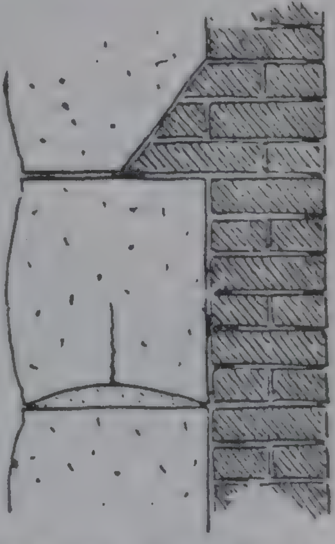


Fig. 182. Section Showing Improper Stone Cutting

In the dressing of the stone, care should be taken to see that the work is as finely cut as called for, and that the moldings are cut according to details and perfectly matched. Ashlar work should be cut with full bed joints without hollows or thin edges, Fig. 182, and so as to lie on its natural bed. Anchors should be freely used, and the bonding of ashlar and backing carefully watched. The setting of columns, arch stones, and molded work should be especially noted to see that the mortar is kept well back from the edges to prevent the stones from splitting off, and the tying of continuous courses to each other at the ends should be insisted upon. Projecting courses must be beveled off on the top to shed water and should also have a drip cut on the under side, so that the water will drop off and not run down the side of the building, Fig. 183. The bed which lies in the wall, however, must not be beveled, but must be cut level to maintain the full bearing of the stones in the wall.

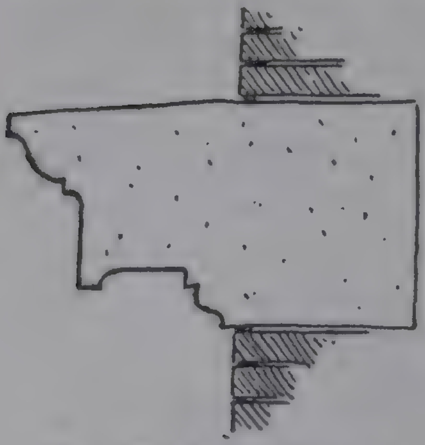


Fig. 183. Section Showing Drip of Cornice Stone

ROOFING WORK

After the completion of the exterior masonry of a building comes in most cases the covering-in, since practically nothing more than the rough work of flooring can be done inside until the work is protected from the weather by a roof. For the roof covering, a variety of materials may be used, common among which may be mentioned tin, copper, slate, tiles, asbestos shingles, and, for flat roofs, tar and gravel composition. There are besides many patented preparations of paper and tar suitable for temporary roofs.

Tin Roofs. The cheapest, and at the same time the least satisfactory of permanent roofing materials is probably tin. This may be used on steep roofs or on comparatively flat roofs, the least inclination advisable being $\frac{5}{8}$ inch to the foot.

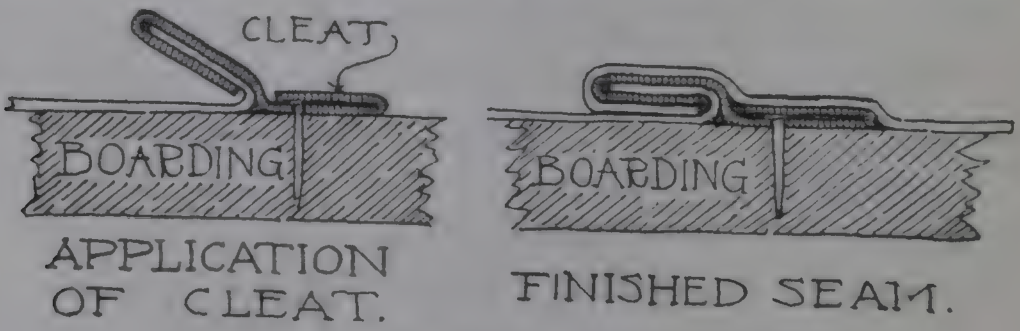


Fig. 184. Flat-Seam Tin Roofing for Flat Roofs

Method of Laying. The boarding under a tin roof should be smoothly matched and covered with dry sheathing paper, and any holes in the boarding should be filled up. The sheets of tin for a flat roof are prepared by turning the edges over so as to lock with the edge of the next sheet, Fig. 184, and they should be painted on the underside and allowed to dry before being laid. The usual method is to run the sheets in courses across the roof, each course being nailed at the top with short wire nails under the lap of the tin. This method of fastening should not be permitted in a roof of any extent, as the rigid nailing of each sheet will give the roof a wavy appearance when the metal expands, and the wrenching of the tin will often draw out the nails or tear the tin from the heads. If this occurs, the great mass of tin will rattle against the roof, and will be, besides, liable to leak. The proper way to secure the tin is by the use of strips of tin called cleats, cut about $1\frac{1}{2} \times 4$ inches. These cleats should be locked over the turned edge of the sheet and nailed to the roof, being concealed by the next sheet added; they should be used about every 14 inches along the upper edge and the side of the sheet of tin. This method of laying tin allows the metal to expand without drawing the nails or destroying the tin. When the roof has been covered, the seams are all pounded down and carefully soldered, making a continuous covering.

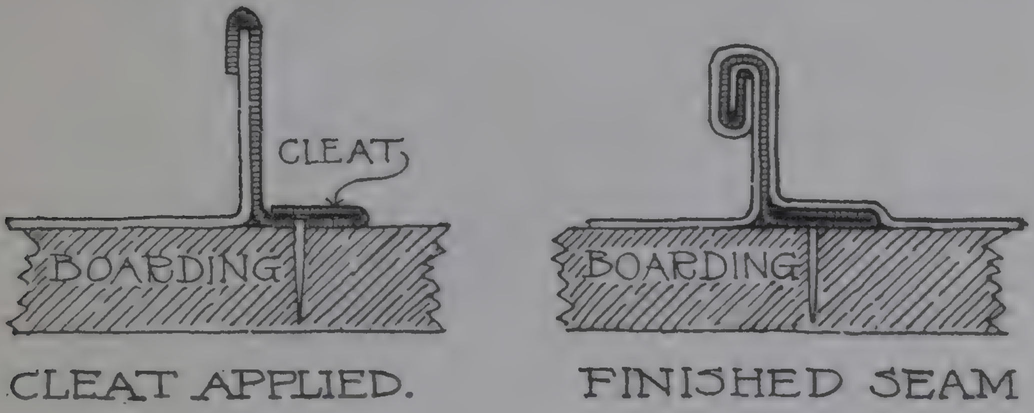


Fig. 185. Standing-Seam Tin Roofing for Large and Steep Roofs

Against chimneys, dormers, or other openings in the roof, the tin should be turned up at least 4 inches to be capped by vertical flashings of lead or zinc, with gable ends carried out and tacked over the edge of the moldings and finish. Connections should be made with metal gutters and finish by locking and soldering.

For large and steep roofs of tin, greater allowance must be made for the expansion, and this is done by means of standing seams, Fig. 185, which are formed by locking together vertically the sloping seams of the tin, the horizontal seams being flat. To do this the sheets of tin are locked and soldered together into strips running up the roof, and these strips are turned up and locked together without soldering, being held in place by cleats. When finished, the seam should be about an inch in height. Standing seams are often used for effect, and a still stronger appearance may be given by ribs of wood over which the tin is locked.

Quality of Tin. The tinning of a roof should be carefully watched to see that tin of the required quality is used, that the cleats are put in as described, and that acid is not used in soldering. Only resin should be allowed as a flux for soldering, as acid, which is more easily used, injures the tin. The standard sizes of roofing plates are 14×20 inches and 20×28 inches; and they are made in two thicknesses marked IC and IX, the former weighing 8 ounces to the square foot and the latter 10 ounces. The lighter brand is more extensively used, but for first-class work and flashings, nothing but IX tin should be permitted. Imperfect sheets, called "wasters", are put upon the market, and are packed in boxes marked ICW or IXW according to the thickness, so that when perfect plates, called "prime", are called for, the superintendent should reject any boxes marked W. The best grades of tin are now sold with the name of the brand and the weight stamped on every sheet, and this should be noted for first-class work. It is worth remembering that the smaller sheets will make a stronger and better roof than the larger, and for a steep roof with standing seams the sheets should be laid with the width between the sloping seams, as this gives more chance for expansion. All traces of resin should be removed, and the roofs should not be painted until the rain has had a chance to wash the tin clean of grease.

Supervision. Tin roofs, while under construction, should be kept clean, and rubbish never allowed to collect, as nails and other hard substances are likely to cause perforations in the roofing if stepped on by careless workmen. If tin is used for fireproofing a roof, the top filling should be of porous terra cotta to receive the nails, and an even surface secured by smoothly plastering the surface of the terra cotta with hard cement. Steep roofs are often made fireproof by using hollow terra cotta tiles between T-irons, which may be treated in the same way.

Standard Practice. The National Association of Sheet Metal Contractors has made the following recommendations as a guide for standard practice:

Tin-Roofing Specifications

Tin Roofing Work. All tin used on this building shall be ——— brand. No substitute for this brand will be allowed. Use IC thickness for the roof proper, decks, etc., and IX thickness for valleys, gutters, and spouts, as required by design. One coat of red lead, iron oxide, metallic brown, or Venetian red paint, with pure linseed oil, shall be applied to the underside of the tin before laying.

For Flat Seam Roofing. Edges of sheets to be turned one-half inch; all seams to be locked together and well soaked with solder. Sheets to be fastened to the sheathing boards by cleats spaced eight inches apart, cleats locked into the seams and fastened to the roof with two one-inch barbed wire nails; no nails to be driven through the sheets.

For Standing Seam Roofing. Sheets to be put together in long lengths in the shop; cross-seams to be locked together and well soaked with solder; sheets to be made up the narrow way in the rolls and fastened to the sheathing boards by cleats spaced one foot apart.

Valleys and Gutters. To be formed with flat seams well soldered, sheets to be laid the narrow way.

Flashings. To be let into the joints of the brick or stone work, and cemented. If counter-flashings are used, the lower edge of the counterpart shall be kept at least three inches above the roof.

Solder. To be of the best grade, bearing the manufacturer's name, and guaranteed one-half tin and one-half lead—new metals. Use only resin as a flux.

Caution. No unnecessary walking over the tin roof or using same for storage of material shall be allowed. In walking on the tin, care must be taken not to damage the paint nor break the coating of the tin. Rubber-soled shoes or overshoes should be worn by the men on the roof.

Painting Tin Work. All painting of the tin work to be done by the roofer, using red lead, iron oxide, metallic brown, or Venetian red paint, with pure linseed oil—no patent dryer or turpentine to be used.

All paints to be applied with a hand brush and well rubbed on. Tin to be painted immediately after laying. A second coat shall be applied in a similar manner two weeks later.

No deviation from these specifications shall be made unless authority is given in writing by the architect. Only a first-class roof will be accepted.

Copper Roofing. The methods of laying copper roofing differ very little from those described for tin, except that the sheets of copper are much larger and therefore lend themselves more easily to molded forms, such as ridge rolls, hips, finials, etc. Copper roofing is often "crimped", that is, the surface is covered by fine corrugations, which give a softer and more even appearance than the plain metal, and conceal the waviness which plain sheets may show.

Slate Roofing. On roofs which pitch more than 5 inches to the foot, slates may be used. With a slate roofing the boarding should be matched and covered with tarred paper. On this surface the slates are laid in layers, beginning at the eaves with a double course and working upward to the ridge. The gaging of the courses is determined by the head cover, that is, the distance which the top of the slate is overlapped by the second slate above, Fig. 186. This lap should not be less than 3 inches.

Slates are usually 8×16 inches and 10×20 inches in size, and run from about $\frac{3}{16}$ to $\frac{1}{4}$ inch in thickness. They should be put on with tinned, galvanized, or copper nails, two to each slate, and care must be taken that the nails are driven in, not hard enough to crack the slates, and yet hard enough to prevent them from rattling. The nails should have large heads and be 3-penny or 4-penny nails. Where slates are cut, as against hips or valleys, care should be taken that each slate receives two nails. For thick slates the holes should be drilled and countersunk. First-class work requires that the slates, for a distance of 2 feet each side of valleys and above gutters, should be "rendered", that is, bedded in elastic cement, and the same precaution should be taken for the width of a foot at hips, ridges, and all vertical parts. If slating is to be used on roofs of very slight slope, the whole should be laid in cement.

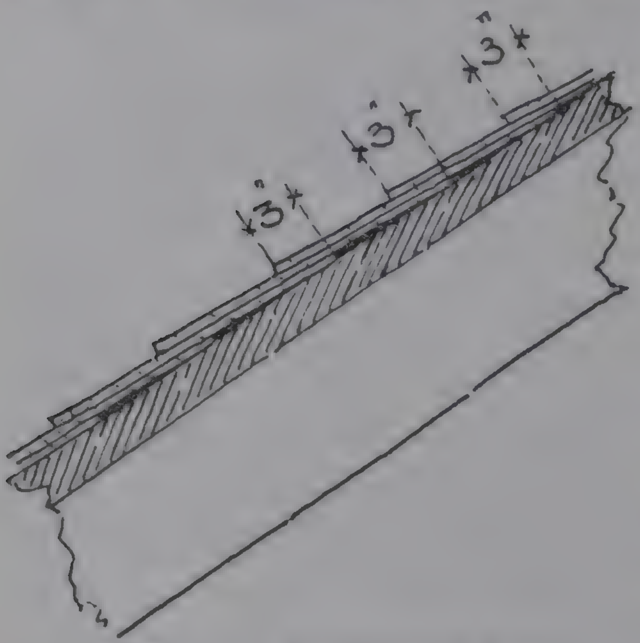


Fig. 186.. Head Cover of Slates

Slate Roofing on Flat Roofs. Flat composition roofs are often surfaced with slate in place of the final coat of gravel or slag, the process up to this point being the same as if a gravel finish were to be used. This produces a roof which may be freely walked upon and permits the removal of snow without injury, whereas a gravel coating is a protection mainly against the elements, and is not suitable for use unless further protected.

Flashings. Valleys in slate roofs should be open valleys of metal at least 18 inches wide, often laid, like a tin roof, with the end joints locked and soldered and the edges securely nailed to the roof boarding. Tin, zinc, or copper may be used, but copper is to be preferred for valleys, as well as for all flashings. Where the slope of the roof changes or where dormers, chimneys, or other vertical parts cut the roof, wide aprons of metal should be set and turned up against the rising wall to be covered over by the wall covering, or by lead counter-flashings built into the brickwork. Gables are finished by continuous metal members, run at least 8 inches under the slates and tacked over the edge of the wooden finish, or cemented into grooves cut in stone copings, called reglets.

Raggle Blocks. Special blocks made of terra cotta or hard clay and having a reglet cast in the back may be obtained for use at the roof level if it is not desired to flash the back of the wall, or for use as a coping in case the wall is to be covered, Fig. 187. The blocks are made to receive the roof composition, or metal cap flashings, as may be desired. This style of construction is a great convenience where flashings have to be removed.

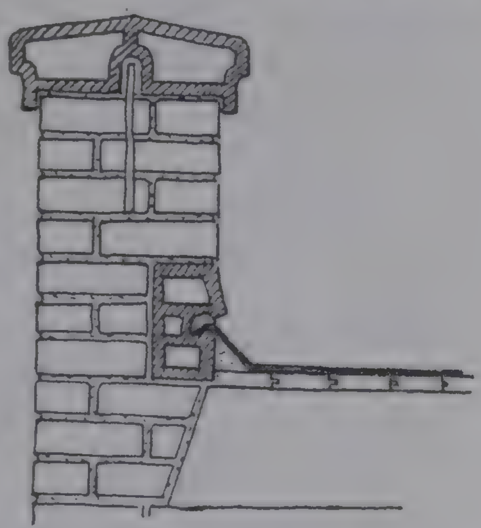


Fig. 187. Section Showing Raggle Block for Holding Roof Composition or Metal Flashings

A good practice is to cap all flashings; that is, the metal which runs under the slates is turned up against the wall, and a separate piece of metal is wedged and cemented into the reglet and turned down over the other flashing to within half an inch of the roof. This method allows free movement to each piece of metal, which is necessary because of expansion and shrinkage. For the same reason it is much better to form the valleys and hips of sheets which are laid in with each course, lapped, and not locked and soldered.

Various Methods of Laying. Slates are sometimes laid on strips of wood or battens without boarding, but this does not make so tight a roof. For fireproof roofs, however, it has been common to secure the slates to small T-bars by bolts and then to plaster the underside, but a better way is to lay porous terra cotta blocks between the irons, to which the slates may be nailed or cemented. A method of slating which may be employed where absolute tightness is not required is one called half-slating, and consists in leaving between the sloping edges of each slate a space not exceeding half the width of the slate, Fig. 188.

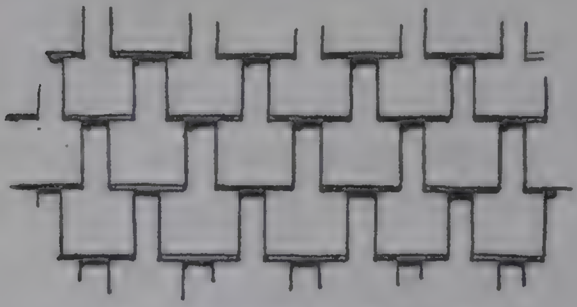


Fig. 188. Half-Slating Roof Covering

Qualities of Slate. In appearance, good slates should be of an even color without spots, and present a hard, straight grain, which should shine in certain lights with metallic, silken luster. They should be square and true, and free from warped or nicked edges, and neither too brittle nor too soft.

Tiles. Tiles for roofing, although by no means a modern invention, have of late years come into more general use in this country. They are made in a variety of shapes, the general principle in all cases being that of a slab of baked clay, molded with an interlocking roll or rim. Tiles are laid on battens or on boarding, as described for slates, but instead of a double lap for tightness, the tightness of this roof depends upon the fitting of the tiles into each other. Some of the modern forms of tiles are shown in Fig. 189. With tiles should be used copper or zinc for valleys and flashings, but ridges and hips are generally formed by tiles of special patterns. Plain tiles have long been used in England and in most cases have been found after years of service to be in as good condition as when new. Tiles may be used on roofs which have a pitch of more than 22½ degrees, but they need a free use of elastic cement, especially in valleys, hips, and ridges. In appearance, tiles should be of even color, free from fire checks but well-burned and nonabsorbent, of uniform size, and without blisters, cracks, or warped surfaces.

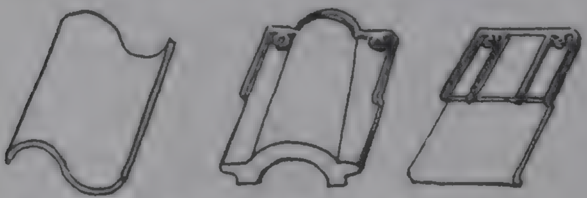


Fig. 189. Standard Shapes of Roof Tiling

Cement Tiles. A variety of roofing tiles is made of Portland cement reinforced with metal. These are molded in large sizes, approximately 2×4 feet, and when laid on steel ribs they present a surface on the underside which requires no further finish, and is suitable for warehouses, machine shops, and power houses where the roof has a reasonable pitch—usually not less than one-fifth of the whole span.

For flat roofs which are to be used for observation or roof-garden purposes, there is a kind of hard tile called "promenade" tile, or quarry tile, which is laid in cement as a paving, and has been used with good results. These tiles, usually from 6×6 inches up to 12×12 inches if square, or in equivalent oblong shapes, should be hard burned and sound and solid in every particular. When well laid in Portland cement they form a pleasing and permanent roof.

Asbestos Shingles. As a substitute for wood shingles, there are shingles made by molding asbestos fibers and Portland cement into a solid sheet under hydraulic or other extreme pressure. These shingles come in various shapes and colors, and are usually $\frac{1}{8}$ inch or $\frac{1}{4}$ inch thick; the latter are made with rough edges to resemble tiles or slate, but they are much lighter and tougher, allowing a lighter roof construction. The $\frac{1}{8}$-inch shingles are less pleasing than the thicker ones as they present a surface extremely smooth and uniform in appearance; they are made in patterns which run to diagonal as well as horizontal lines on the roof.

Selection having been made, the laying does not differ from the familiar construction of slate or tile covering, equal care being necessary to see that proper metal flashings are introduced in the portions especially exposed to rain or snow.

Composition Roofing. For roofs of a pitch of $\frac{3}{4}$ inch to the foot or less, a composition roofing, made of several thicknesses of paper coated with tar and covered with gravel on top, may be used to advantage. The mode of constructing a composition roof over wood consists, first, in covering the boarding with dry resin-sized felt with a lap of 2 inches, tacked only often enough to hold it in place. Over this are laid two full thicknesses of tarred felt, each sheet lapping two-thirds of its width over the preceding one, and the whole covered with a uniform coat of pitch mopped on. Upon this coating three layers of tarred felt are tacked, each lapped about 22 inches, and the whole mopped over and a thick coat of pitch flowed on. As the durability of the roof depends upon the paper, only the best should be used, and the pitch should not be so hot that it will destroy the life of the paper. Upon the final coat of pitch is spread immediately, as a protection, a coat of clean, white gravel, completely covering the whole, Fig. 190.

In the case of a composition roof laid over a concrete surface, the operations are the same except for the first mopping of pitch directly upon the concrete, and the omission of the nailings which are required on a wooden roof, their place being taken by moppings of pitch.

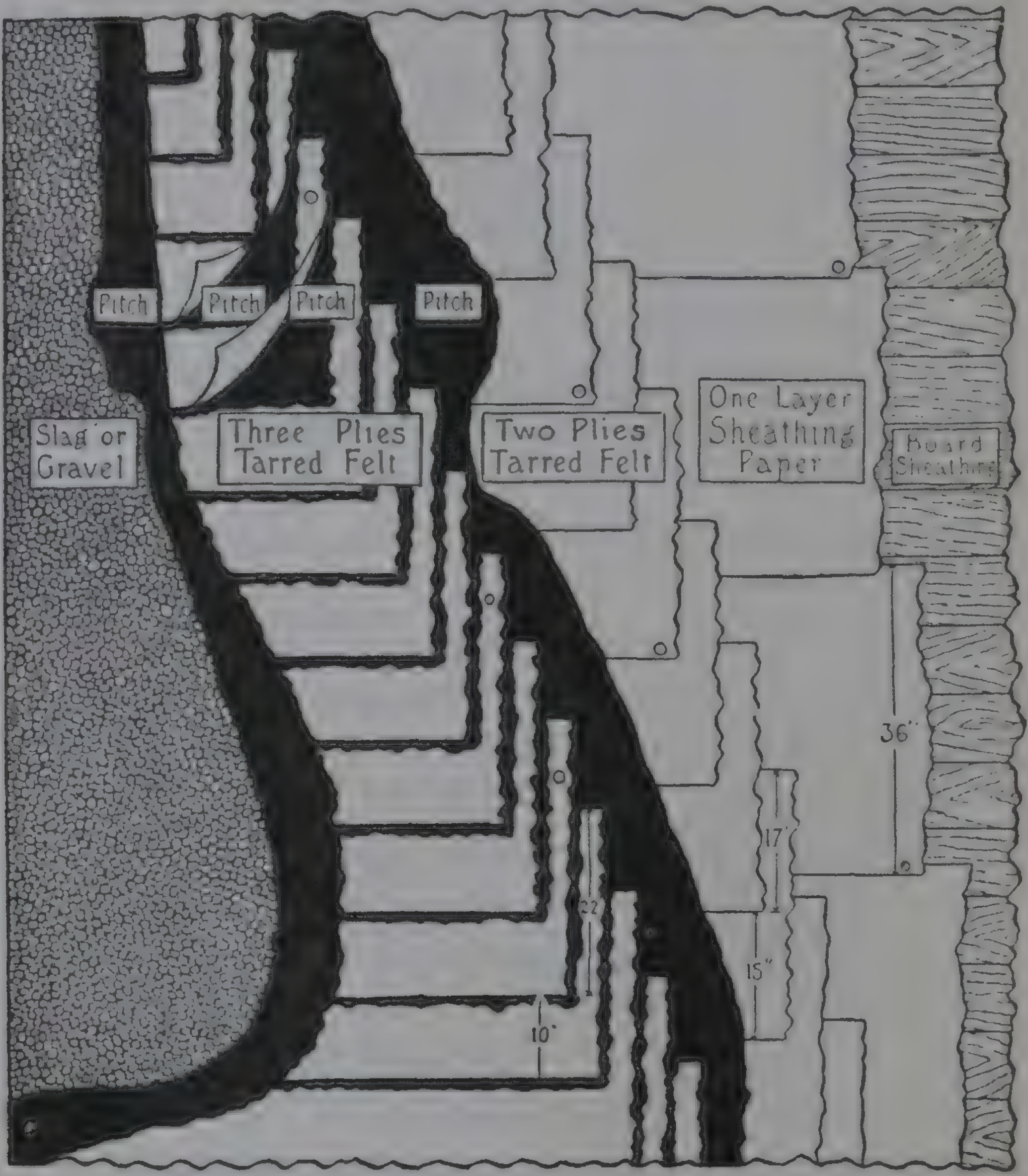


Fig. 190. Section Showing Layers of Composition Roofing on Board Sheeting
Courtesy of Barrett Manufacturing Company, New York City

This composition of tar and gravel makes a very good roof, but it is suitable only for roofs with a grade up to $\frac{3}{4}$ inch to the foot. If the roof is much steeper, the heavy coats of pitch will run in hot weather and, settling down, will gradually fill the gutters. A composition of pulverized slate and asphalt, applied in layers with felting, has been placed upon the market, and is more adaptable to various roof angles than tar and gravel.

The same precautions regarding the flashing of vulnerable parts that we have noted for slates or tiles, are needed in the laying of composition roofs, except in the case of the *plastic-slate* roofing; here the composition itself is of such a nature that it may be applied with a trowel directly to the walls or copings against which the finish is made; and since it is both elastic and adhesive, no great amount of metal flashing is needed.

Specifications for the Application of Pitch and Felt Built-Up Roofing with Gravel or Slag Surface

Incline. This specification should not be used where roof incline exceeds three (3) inches to one (1) foot.

Standard Specifications for Use over Board Sheathing

Roofing. *First*, lay one (1) thickness of Sheathing Paper or Unsaturated Felt weighing not less than five (5) pounds per one hundred (100) square feet, lapping the sheets at least one (1) inch.

Second. Over the entire surface lap two (2) plies of Specification Tarred Felt, lapping each sheet seventeen (17) inches over preceding one, and nail as often as is necessary to hold in place until remaining felt is laid.

Third. Coat the entire surface uniformly with Specification Pitch.

Fourth. Over the entire surface lay three (3) plies of Specification Tarred Felt, lapping each sheet twenty-two (22) inches over preceding one, mopping with Specification Pitch the full twenty-two (22) inches on each sheet, so that in no place shall felt touch felt. Such nailing as is necessary shall be done so that all nails will be covered by not less than two (2) plies of felt.

Fifth. Spread over the entire surface a uniform coating of Specification Pitch, into which, while hot, imbed not less than four hundred (400) pounds of gravel or three hundred (300) pounds of slag to each one hundred (100) square feet. The gravel or slag shall be from one-quarter ($\frac{1}{4}$) to five-eighths ($\frac{5}{8}$) inch in size, dry and free from dirt.

Flashings. Flashings shall be constructed as shown in detail drawings.

Inspection. The roof may be inspected before the gravel or slag is applied by cutting a slit not less than three (3) feet long at right angles to the way the felt is laid.

Supervision of Roofing Work. The supervision of roofing work of all kinds deserves the closest attention. Nothing is more unsatisfactory than to find leaks in the roof of a new building, and the time spent in securing a first-class job will be well spent. Slates and tiles are easily broken, and unless discovered and brought to notice at once, the broken ones will probably be overlooked by the contractor. Composition roofs are easily slighted, and when finished give little indication of defects; the only practical way of determining that felt and pitch have been applied as specified is to cut a slit into the roof "not less than three feet long at right angles to the way the felt is laid", before the gravel or slag is applied. The cut can be repaired by laying five thicknesses of felt over it, and the spot will then be as strong as any part of the roof.

METAL WORK

Gutters. The best material for metal conductors is copper, but galvanized iron and tin are used to some extent. The usual type of copper gutter is shown in Fig. 191, but it is often necessary that the face should be made of moldings to match or form part of a stone or wooden cornice. In such a case, the gutter is formed behind the finished molding, Fig. 192. The gutter shown in Fig. 191 is made of sheet copper, turned over an iron bar *A*; it is molded to form the trough, and made wide enough to run well up on the roof boarding, under the slates or other covering. Bars of copper or galvanized iron are bolted to the outer bar, and nailed and soldered to the roof. These bars should be given a short twist, as shown, so that the wash of the roof will drip off into the gutter, and not follow the strap down and soil the face of the gutter. In the case of the lined gutter, Fig. 192, the outer edge of the metal is tacked to the wood or tucked under an iron bar previously secured.

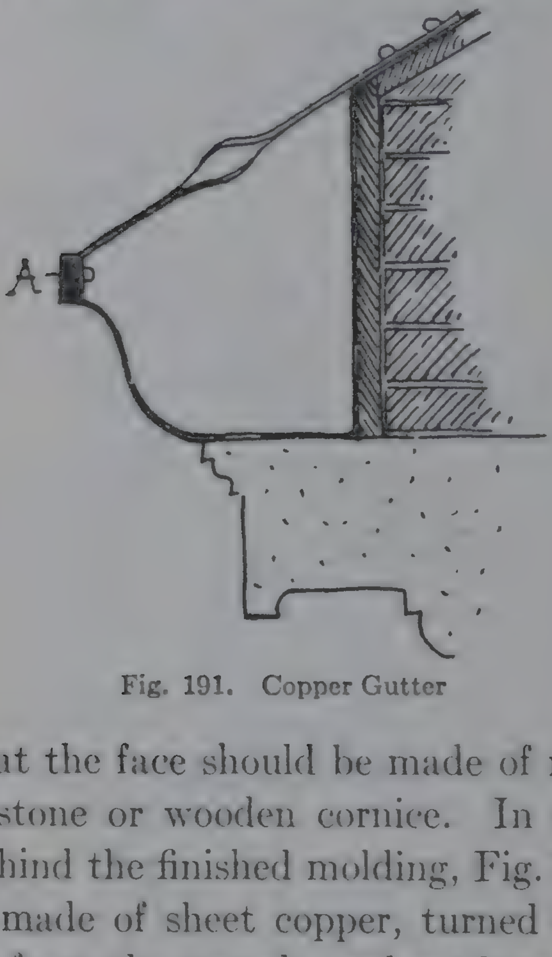


Fig. 191. Copper Gutter

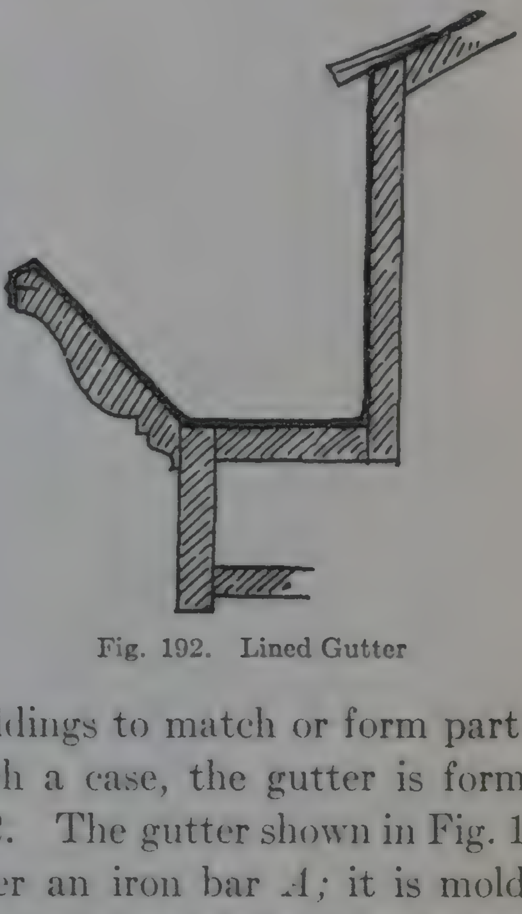


Fig. 192. Lined Gutter

Standing gutters, Fig. 193, are sometimes used, where they will not be objectionable by reason of holding back the snow, but they are often a source of trouble.

In a great many cases of city building, especially of buildings with flat roofs, it is necessary or convenient to have the outer walls carried up as a parapet, and the roof water taken care of inside of the building. In this case a cant board is used, Fig. 194. This consists of a board surface set in the angle of roof and wall, and graded to the desired outlets, where conductors are placed inside of the wall.

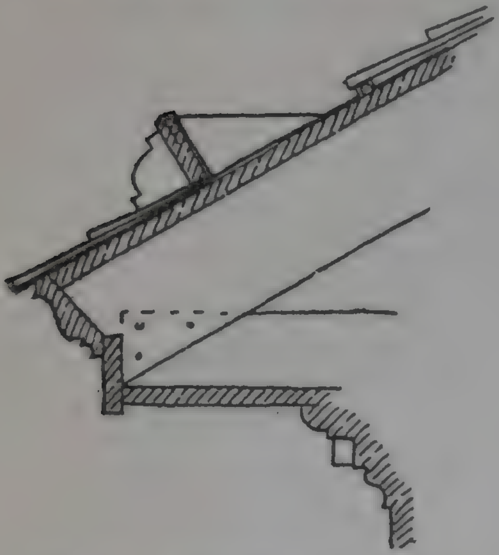


Fig. 193. Standing Gutter on Roof

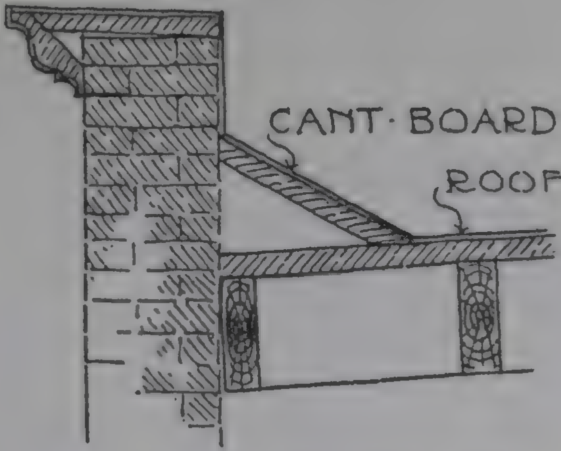


Fig. 194. Cant Board behind Parapet

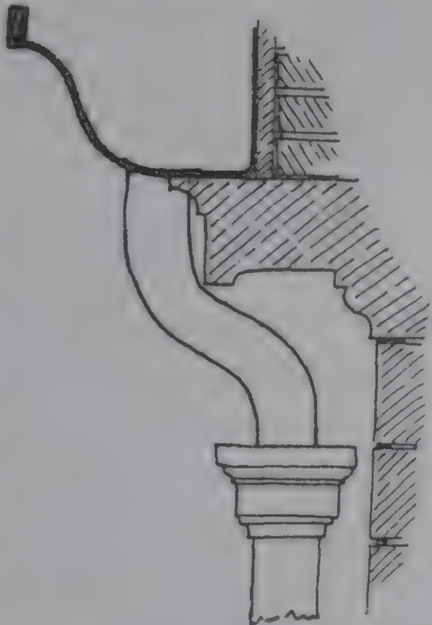


Fig. 195. Gooseneck Connectio
between Conductor Pipe
and Gutter

Conductors. In the case of the inside conductors referred to, cast-iron soil pipes may be used; and if these are carried down in a brick wall, they should, if possible, be run in interior walls, with not less than 8 inches of wall between them and the outside air. The recess is often packed with some nonconducting material. Outside metal conductors are made of tin, zinc, galvanized iron, or copper, the latter being the most desirable and also the most expensive. Metal conductors should be made in some form which will permit expansion in case their contents are frozen solid. A corrugated round pipe or an octagonal or square pipe is to be preferred. Conductors are usually given ornamental tops of large or small proportions according to situation.

The connection between the conductor and the gutter is generally made by a bent piece of pipe, sometimes a continuation of the conductor, but often a separate piece of lead pipe, shown in Fig. 195, called a gooseneck. The opening from the gutter to the conductor should be protected by a strainer to prevent leaves, chips, or other substances from choking up the pipe, and the lower end, if connected with a drain, should be properly trapped.

Supervision. The superintendence of gutters and conductors should cover the construction of the trough, if of wood to be lined, to see that it pitches in the right direction and to the required points. The weight of the metal should be examined, and the manner of securing both gutters and conductors carefully noted. Tin or iron surfaces which are concealed should be well painted, and all soldering faithfully done. The ends and backs of metal gutters must be examined to see that there is a sufficient width of metal to turn up against the wall, or to lie up on the roof, 8 to 10 inches being as little as it is safe to allow. All rubbish in the gutters must be removed, and all connections left tight and free from obstructions.

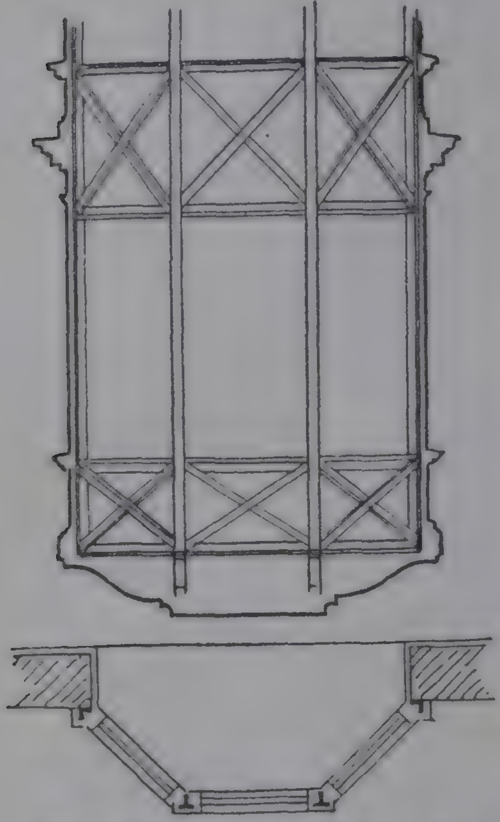


Fig. 196. Framing for Metal Bay Window

Galvanized Iron Work. The use of galvanized iron for exterior molded work and bay windows has of late years become an important factor in building construction. Especially is this true of modern fireproof buildings where it is desired to avoid the use of wood in the exterior finish. Belts, cornices, pilasters, door and window finish, and, in fact, all the trimmings of a building, which in former times would have been made of stone or wood, are now, to a great extent, made of galvanized iron or, if not too costly, of copper. The structural treatment of galvanized iron and copper being about the same, it is necessary for us to treat only of the former, remembering that for large surfaces galvanized iron is the stouter material.

Bay Windows. Perhaps the greatest use of galvanized iron at present is found in building bay windows. Since in this construction the essentials are lightness and strength, it is usual to erect a light framework of steel, upon which the metal finish is secured, Fig. 196.

Cornices. Cornices are run on steel or iron brackets secured to the brick wall or the steel frame, whichever is more available. These brackets are shaped to conform roughly to the outline of the cornice, and it is allowable to insert a reasonable amount of boarding to form a base for any broad washes of metal, as boarding thus placed, outside of the walls and completely encased by metal, is not in any danger from fire. For heavy projecting cornices, the brackets should be made of steel angle irons securely built into the wall, or bolted to it or to the steel skeleton.

Tinned Doors and Shutters. Doors covered with tin are frequently used for the fire protection of exposed windows and other openings. Many city laws and insurance rules require that all windows within thirty feet of a source of danger from fire shall have metal-covered shutters of some kind. A wooden shutter completely encased in tin has been found to be an effective protection. For guarding openings in party or division walls, the same kind of doors are used, one on each side of the wall, leaving an air space between of about the thickness of the wall, Fig. 197. The laws generally require that these doors shall be set in rebated frames, and hung by various automatic devices of weights and fusible members, so that they will close at once if attacked by fire.

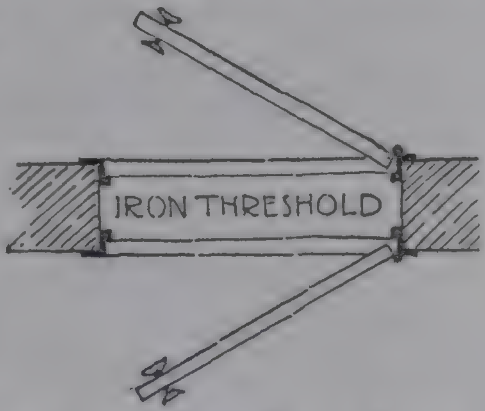


Fig. 197. Section Showing Typical Fire Doors

The best type of construction has a frame made of pine $1\frac{3}{4}$ inches in thickness with flush panels, covered with tin tacked on as described for roofing; shutters and small doors, however, are built of two thicknesses of $\frac{7}{8}$-inch pine, nailed together and crossing each other. As much care is necessary to preserve a tight interior for outdoor shutters as for a roof, as a small leak will soon rot out the pine core. The joints are all made by locking and tacking the tin; soldering is prohibited, since the heat of a fire would melt it at once.

Skylights. Another use of metal for exterior work is found in the framework of skylights. These, if large, are made of light steel angles or T-irons, and covered with sheet metal, sometimes with a lining in parts of terra cotta blocks. If the frames are of ordinary size, they are formed of heavy sheet metal, usually galvanized iron or copper, and they come in a variety of designs suited to different uses. The two principal forms of skylights are the hipped skylight, Fig. 198, and the gabled skylight, Fig. 199. All skylights should be provided with ventilators of some sort; often a greater circulation of air is obtained by building a vertical wall containing sashes or louver blinds.

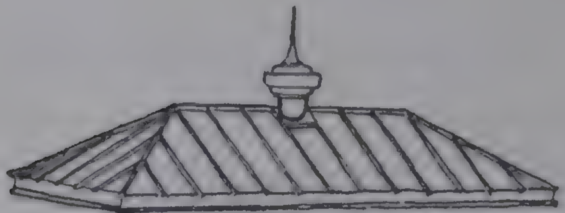


Fig. 198. Hip Skylight

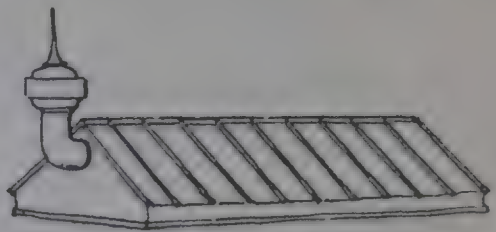


Fig. 199. Gable Skylight

Roof Houses. Roof houses, often necessary to give access to roofs or to house machinery, are constructed similarly to large skylights, but without the glazing or louvers in the walls. If more than 40 feet above the sidewalk, they must be, according to the building laws of many cities, of fireproof construction, and they are usually made of T-irons with a terra cotta filling covered with sheet metal, Fig. 200. It is essential that the T-irons be set with their flange inside or on the opposite side from the metal covering; otherwise the pounding-down of the seams of the metal will be likely to start the terra cotta out of place. On account of this pounding-down of the seams, it is often better that the blocks should be of solid terra cotta and not hollow tiles. The connection between these houses and the main roof must be taken care of as already described for roof and wall flashings, due allowance being made for expansion of the metals. It may be well to note here that zinc for

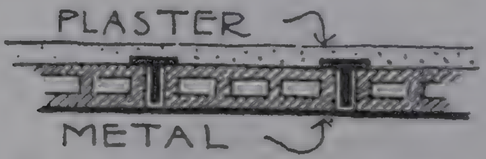


Fig. 200. Typical Hollow Tile Wall

flashings should never be used where it will come in contact with iron, lead, or copper, as this contact will produce voltaic action which would finally destroy the zinc.

FLOOR FRAMING

General Features for Various Buildings. The exterior wood framing of city buildings is in most cases confined to roofs, since no exterior walls within building limits of modern cities may be constructed of wood. Wooden roofs covered with slates or other fire-resisting materials are allowed, however, in many cities, up to a certain height above the sidewalk. The only difference which we shall find in this wooden construction from the suburban house considered in Part I is that usually the spaces to be covered are larger and the roofs, consequently, must be heavier. Floors also must be stronger, and because of the variety of city structures—from comparatively light buildings to heavy stores and warehouses—a great range in floor construction is required in their erection.

CITY DWELLINGS

For brick dwellings the floor construction differs little from the wooden houses already described, the principal differences being that the spans are greater and, consequently, the timbers are heavier, and also the fact that the outside bearings are taken by the brick walls instead of by wooden girts. The joists in this case should run on to the wall at least 4 inches and should be beveled at the end, so that in case of fire the floors may fall without destroying the wall, Fig. 201. The joists must be anchored to the walls about every

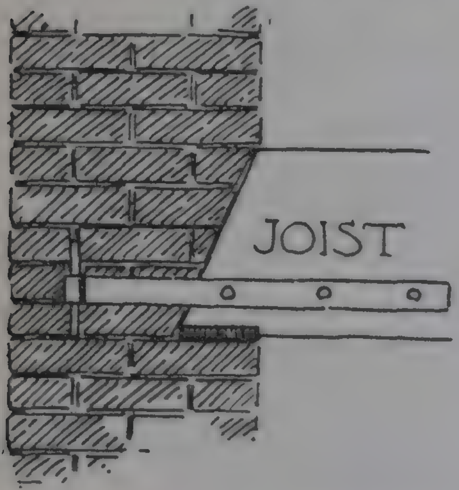


Fig. 201. Section Showing Beveled Floor Joists

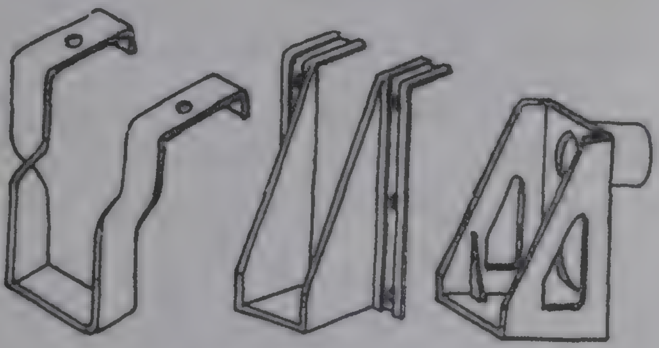


Fig. 202. Typical Joist Hangers

five feet with iron ties secured to the joist at the side, and low down, to allow the joist to fall out if burned. These ties should be continued across the building by tying the inner ends of the joists together and putting an anchor in the opposite wall, in as nearly a direct line across the house as possible. All large timbers, such as girders, should have anchors and should rest on cast-iron wall plates. Partitions carrying floors should have a stud set close against the brick wall and bolted to it, and all large openings, such as stair wells or skylights, should have headers hung to the trimmers by stirrup irons or patent hangers, shown in Fig. 202.

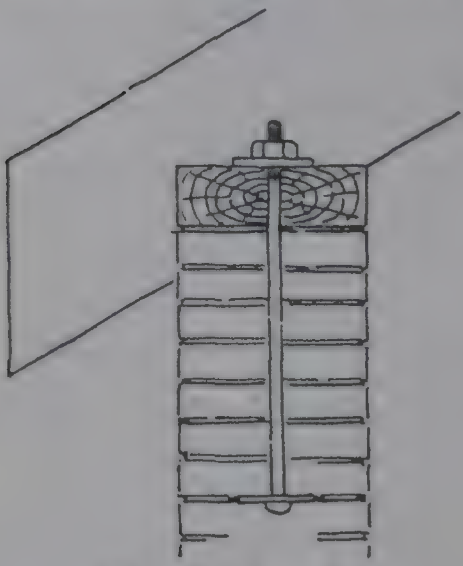


Fig. 203. Plate Bolt

If there are openings in the brick walls which come so near to the bottom of the joists that an arch cannot be turned, a header should be cut in, or a steel beam inserted in the wall. Joists are sometimes fastened to the walls by hangers, and do not run into the wall at all; but while this preserves the full strength of the wall, it does not make so good a tie and is not generally done. The wall plate of a brick dwelling is usually made of a plank the thickness of the wall, secured by $\frac{3}{4}$-inch bolts which are built into the wall, as in Fig. 203. These bolts should run at least 20 inches down into the wall, and have a large washer plate at their lower end. When the wall has been brought to the required height, the plate is bored with holes to fit the bolts, and a nut and washer screwed on. Over the plate the rafters are notched, and the roof constructed as for a wooden house.

STORES AND OFFICE BUILDINGS

In the construction of stores, warehouses, or office buildings, with wooden floors, the use of partitions for carrying the floor should be avoided, and columns and girders substituted. The reason for this is that under heavy loads the studding will often spring enough to crack the plastering, and, besides, the occupancy of this class of buildings by different tenants will require numerous changes in the partitions from time to time. The large girders and posts also offer greater resistance to the action of fire, and permit fewer concealed spaces. Many city laws require the use of brick walls, trusses, or columns and girders, for support, if floor spans exceed 30 feet, and this is a good rule to observe.

Wooden Columns. In establishing a line of columns and girders, the columns should be spaced about 12 or 14 feet apart for wooden girders, a spacing that can be increased to 25 feet if steel girders are used. Solid wooden posts will last better, if bored from end to end through the center with a hole about 1½ inches in diameter, and with a ½-inch hole bored into the center at the top and bottom. This allows a circulation of air through the center of the post, and guards against dry rot, especially if the post is not thoroughly dry when set. The central boring should be done from one end, and if it comes more than an inch out of center at either end, the post will be weakened and should be rejected.

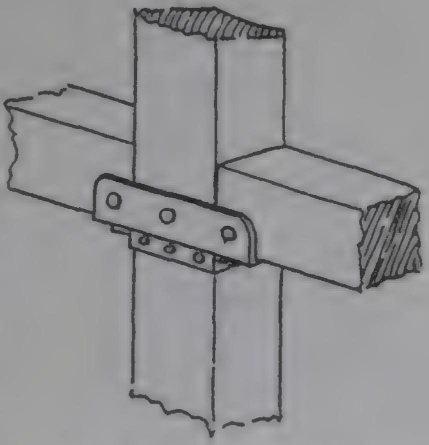


Fig. 204. Steel Post Cap

All wooden posts carrying girders and posts above, should have an iron cap with side plates to receive them, Fig. 204, so that the post above will be supported directly by the post below, and will not stand on the girder. This is necessary for two reasons. One is, that if the girder ran over the top of the post and the post above were set upon it, the shrinkage of each girder would be multiplied by each succeeding floor, and in a building of four or five stories this might amount to 2 or 3 inches; the upper floor beams at their inner end would then be that much lower than the outer ends which are supported by the rigid masonry. Another reason is, that the crushing strength of the girder in its longitudinal position is not so great as the post standing on end, and it might be unable to support the accumulated weight of several stories. This support was formerly obtained entirely by the use of cast-iron pintles, Fig. 205, which

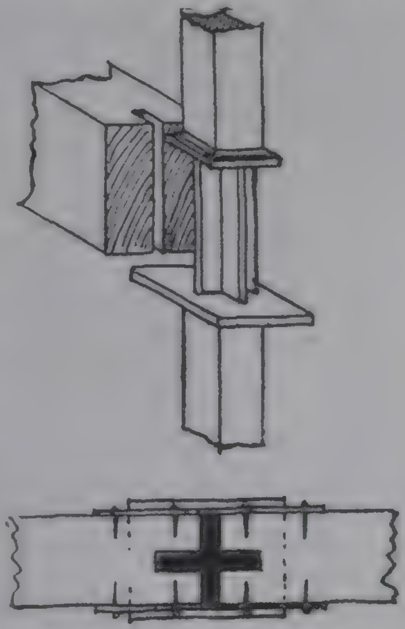


Fig. 205. Elevation and Plan of Cast-Iron Pintle

were molded with top and bottom plates to fit the posts, the weight being transmitted by the cross-shaped metal. This is an effective method, but has been superseded by the more modern steel caps. The bearing of the girders should be at least 5 inches on either end, and a box anchor of some kind should be used to support the wall end of the girder, as shown in Fig. 206.

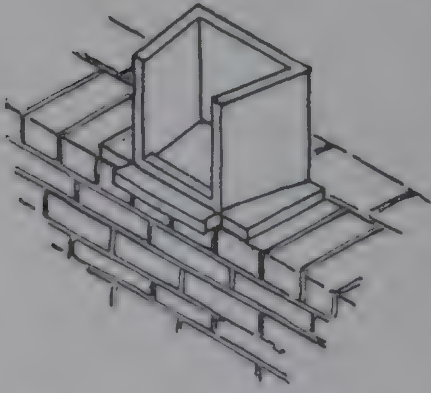


Fig. 206. Box Anchor on Wall

Iron and Steel Columns. For large spans and heavy weights it is often necessary to use iron or steel columns with wooden girders. If cast-iron columns are used, they should be made with a shell not less than $\frac{3}{4}$ inch thick. This is necessary on account of the danger of an unequal thickness in the shell. To obtain the hollow column, the casting must be made about a core, and although this core is accurately centered, there is danger of its being displaced by the pouring-in of the molten iron, since being of a lighter composition, it will have a tendency to "float". This may result in an added thickness to one side of the shell of the column and a corresponding lack of metal on the opposite side. To guard against this defect, cast-iron columns should always be tested by boring small holes on opposite sides, and if more than one-fourth of the thickness of shell is wanting in any column it should be rejected. The outer surface of cast iron should be smooth and clean, with sharp angles; and all projections, such as lugs, caps, or bases, should be closely examined to detect the presence of cracks.

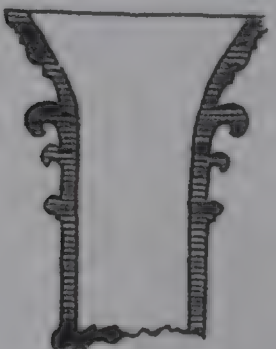


Fig. 207. Improperly Cast Column

Cap and Base. The top and bottom of all cast-iron columns should be turned off in a lathe to insure a bearing at right angles to the axis, and plates should be used to increase the bearing. These plates are cast with a ring or with projections to hold the column in place against movement, and they should be planed to a perfectly even bearing. The cap must never be spread out as a casting, Fig. 207, but should carry up the line of the column itself, all ornamentation requiring a great projection being cast separately and fastened on, Fig. 208. This allows the shaft of the column to run straight up to bear the weight of the column above, while the girder is borne by the projections cast upon the column. The distance from the cap to the top of the column should be about four inches greater than the depth of the girder to give room for bolting the columns together.

With a wooden girder, the ends of the timber must be cut out to fit the diameter of the column, Fig. 209, and the girders must be tied across the cap by stout straps on each side. If steel beams are used, they can be tapped to the column plate or strapped together around the column.

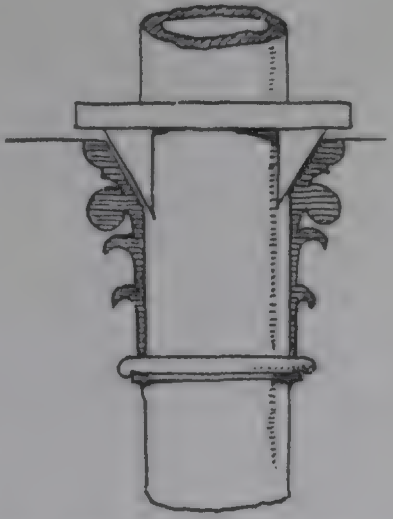


Fig. 208. Proper Application of Ornament to Column

Pipe Columns. Heavy wrought-iron pipe is often used for columns, a cap and base being sometimes cast and screwed on by a thread; and a patented column, formed by filling the pipe with cement, may be obtained ready-fitted with cap and base.

Wooden Girders. If wooden girders are used, they may be set wholly or partially below the floor timbers, or flush with them.

Girders below Floor Timbers. If there are no objections to dropping the girders below, this is the simplest and strongest construction. In this case, the floor beams should be sized down on the girders to maintain a perfectly level floor line, and a full bearing should be obtained for each timber. Where the girders are large, the timbers may be brought to butt against each other upon the girder; and they should be secured end to end by iron dogs which turn down into each timber, Fig. 210. For small girders and light timbers, it is better to let the timbers lap close and be spiked to each other, as in Fig. 211.

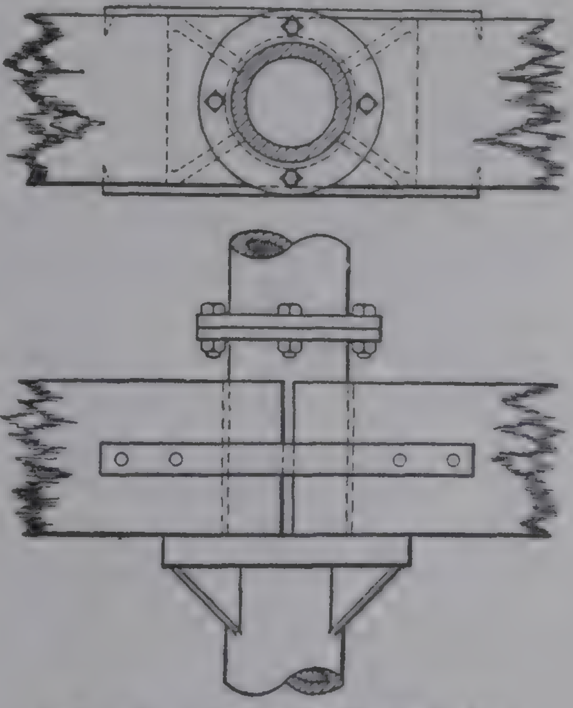


Fig. 209. Method of Seating Girders on Column

When the girders are near together, and the timbers long enough to span two divisions, a rigid floor may be obtained by breaking joints with the floor timbers every five or six feet.

Girders Flush with Floor Timbers. If the girders are to be framed flush with the timbers, the use of stirrup irons or patent hangers is recommended, as preserving the full strength of the girders. In this case the timbers on each side of the girder should be brought opposite one another as nearly as possible, and iron dogs long enough to reach over the girder and drive down into opposite timbers should be used, Fig. 212.

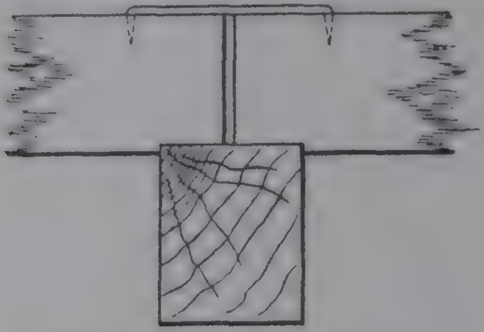


Fig. 210. Use of Iron Dog to Connect Large Girders

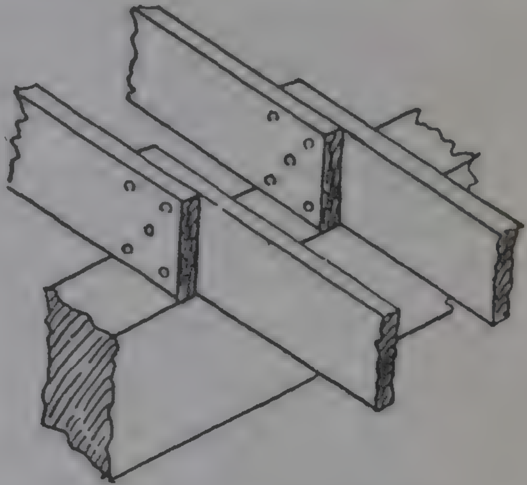


Fig. 211. Spiking of Joists

If the girder is deeper than the floor timbers, it may be set flush on top, and smaller pieces of hard pine or an angle iron may be bolted to the lower part of the girder in order to support the floor timbers, as shown in Fig. 213.

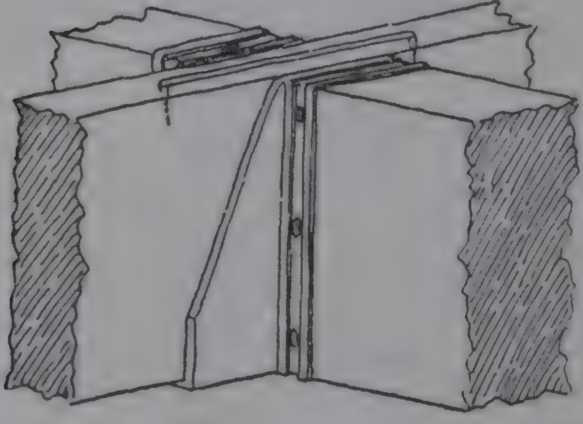


Fig. 212. Use of Patent Hangers for Joists Flush with Girders

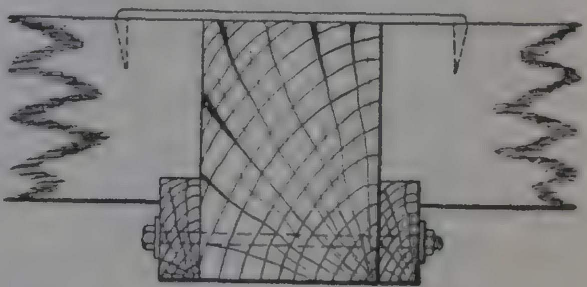


Fig. 213. Method of Making Joists Flush with Girders

Steel Girders. Where the spacing of columns has to be increased beyond the safe bearing of wooden girders, steel girders may be used. These usually consist of one or more steel I-beams, and they may be used with cast-iron columns or with steel columns. With cast-iron columns, the same methods will suffice as are used for wooden girders, but with steel columns a different method of construction is necessary, which it will be better to consider later in connection with steel framing. It may be properly said here, however, that the use of steel girders and steel columns, even if the floor timbers are of wood, is to be recommended for high buildings and for buildings which are subjected to the jar of machinery. The reason for this lies in the greater rigidity which is possible in the girder and column connections, and the greater ease of bracing this construction.

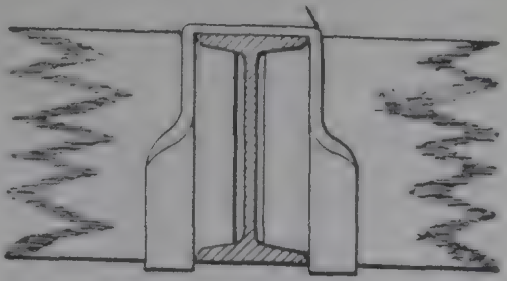


Fig. 214. Use of Stirrup Iron with Steel Girders

With the use of steel girders new considerations arise. If a single girder is set entirely below the floor timbers, it will give a better bearing if the timbers lap and spike to each other. With two or more girders, the timbers may be brought end to end as on the heavy wooden girder. If the steel girder is set flush with the timbers, the latter may be cut so as to run into the trough formed by the flanges of the girder, but they should be supported by stirrup irons or hangers, Fig. 214, as the sloping flange of the steel girder does not afford a good bearing. If the steel girder is deeper than the floor timbers, a common method is to bolt a timber to each side for a bearing; an angle bar can, of course, be used in the same manner, Fig. 215. In any case, the floor beam should be fastened so that there is no danger of slipping out of the hanger. Most of the patent hangers have a lug, or bolt, to secure the timber in place, and where timbers come opposite to one another, common iron dogs turning down into each timber may be used.

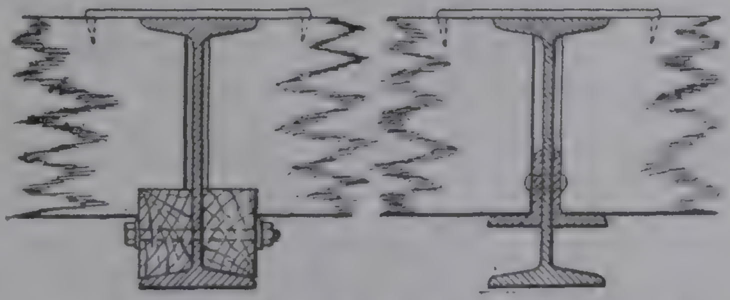


Fig. 215. Fastening Wood Joists to Steel Girders Using Wood Bearing Timbers or Angle Pieces

Crowning of Floor Timbers. All floor timbers having a span of more than 16 feet should be crowned, that is, the top of the joist should be cut to the shape of an arc of a circle, having a rise of $\frac{1}{4}$ inch to every 16 feet of span. This is necessary to allow for the ordinary sag of the timber, so that a level floor will result.

Supervision of Floor Framing. The supervision of the framing of floors of brick buildings calls for constant vigilance on the part of the superintendent. Not only is it necessary to follow closely the work of the carpenters, but the fact that the mason work is being carried along at the same time by a different set of workmen demands a great deal of forethought in order to bring the different parts together at the right time. The anchoring of floors properly, and at the proper time, requires constant attention, and the setting of plates, the building-in of bolts and hangers, and the leveling-up of floors and walls to their relative positions necessitates harmonious action between mason and carpenter.

In heavy framing, careful watching is essential to see that all necessary connections are made between post, girders, and floor beams, and that ties, straps, and bolts are set and tightened. If trusses occur, they should be strained up tightly when built, and kept tightly strained as long as there are any workmen remaining at the building, as the shrinkage of the timbers often loosens the joints and allows sagging to occur.

SLOW-BURNING AND MILL CONSTRUCTION

Slow-Burning Construction. The methods of heavy timbering recently described, with floors of matched or splined plank, and with no wood partitions or furrings enclosing hollow spaces, constitutes what is generally termed slow-burning construction. To obtain the best results from this method of construction, wooden girders should always be set flush with the floor timbers on top, as the dropped girder with the space above will permit flames to lap around the timber so that it will be more quickly consumed than if it is flush with the rest of the floor beams. Greater protection is obtained by covering the wood with plaster on metal laths, leaving no air spaces between the plaster and the wood.

Mill Construction. As its name indicates, mill construction belongs to the particular methods of building which have been devised for resisting fire and for sustaining the loads and shocks of machinery to which manufacturing structures are particularly subjected. This requires primarily the disposition of the timber and plank in solid masses, so that the fewest number of corners will be exposed to the action of fire, the separation of floors by fireproof stops, automatic arrangements for closing hatchways and elevator openings, and incombustible partitions for enclosing stairways.

Beams. The typical construction employed for the mills of New England, and the only form acceptable to the insurance companies of that section, calls for posts at least 10×10 inches, spaced about 8 feet apart in the length of the mill and 24 or 25 feet across. Instead of a line of girders running lengthwise over the line of posts, the floor beams are laid across the mill on the top of the posts. These beams are usually 12×14 inches, or in two pieces each 6×14 inches, bolted together with an air space between. The wall ends should rest on iron plates, and the ends should be beveled off and secured only at the bottom, so that they may fall out easily if burned and not pull down the wall, Fig. 216. These beams are supported by iron post caps or pintles, as already described.

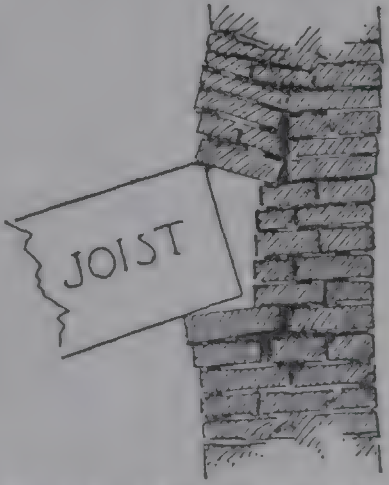


Fig. 216. Effect on Brick Wall of Not Beveling Floor Joists

Flooring. The flooring consists of a layer of 3-inch planks not more than 10 inches wide, splined together and blind-nailed; it should be long enough to span two spaces, breaking joints every 4 or 5 feet. All of this construction is usually of Georgia pine.

The upper floor is generally made of hardwood, such as maple or birch, and this is laid with square edges over two or three thicknesses of paper, each layer being mopped with tar, asphalt, or some similar material; sometimes a layer of plaster is spread between the upper and under floors.

Partitions. Where slow-burning or mill construction is used for the floors of a building, the partitions should be made of solid plank, plastered on both sides on metal lathing, or else of light steel framing with metal lath and plaster.

Roofs. The same methods of framing may be employed for the roofs as for the floors, but lighter timbers can be used, set to the required pitch, with a tar and gravel or metal roof. Sharply pitched roofs may also be constructed in the same way, the timbers being trussed if the span requires it.

Adaptation to Mercantile Buildings. This style of construction may be adapted to the use of mercantile or office buildings, but the general requirements of this class of buildings do not allow posts to be placed so often as every 8 feet. This necessitates the use of girders and intermediate beams. If these beams are spaced 4 or 5 feet apart, it permits the use of 2-inch plank which may be tongued instead of splined. With the increased spacing, the posts must be made of iron or steel for a building four stories or more in height; and if the posts are more than 14 feet apart, it will be cheaper and better to use steel beams for girders. In this case all weight-bearing metal must be protected by at least an inch of plaster or other fireproof material.

FLOORING

WOODEN FLOORS

Rough Floor. As soon as the floor timbers are in place, it is the custom generally to lay a rough floor. This makes a platform upon which subsequent operations are carried on and also forms the foundation for the upper or finished floor. The character of this rough lining floor depends upon the nature of the floor framing. If it is of slow-burning or mill construction, with the beams far apart, plank must be used, of varying thickness according to the spacing of the beams. For a spacing of 4 or 5 feet, 2-inch plank may be used, but a spacing of from 5 to 8 feet requires 3-inch plank. This planking should be matched or splined and securely nailed to every bearing; if it is laid diagonally, it adds to the rigidity of the building and gives besides an even surface upon which to lay the finished floor.

For the under floors of dwellings or other buildings of ordinary light construction, $\frac{7}{8}$-inch hemlock or pine is generally used without matching. The boards should be mill-planed to an even thickness and as narrow as can be readily obtained. They should be securely nailed to every bearing, and laid close to the exterior walls, covering the surface completely, with no large holes or wide crevices.

Finished Floor. The laying of the upper floor should be delayed until the rooms have been completed up to the hanging of the doors. For floors that are to be carpeted, spruce or pine is generally used, and this may be laid without matching. For floors not carpeted, hardwood should be used, the boards sawed into narrow widths, matched, and blind-nailed.

The floors of kitchens, offices, and other places where much wear will come and where the expense of oak or other fine woods is not desirable, may well be of rift Georgia pine. Birch and maple also make good floors and have satisfactory wearing qualities. When laid on sleepers securely bedded in concrete, with no chance for the air to get beneath the floor, they are in little danger of being consumed by fire. In parlors, halls, and for parquetry flooring, oak is used to a great extent, either by itself or in combination with other fancy woods.

Wooden floors should be matched and tightly laid, and treated with as little oil or inflammable varnish as possible, depending upon constant care for preservation rather than on a great amount of finishing. All hardwood flooring should be quarter-sawed. The usual thickness of flooring stock is $\frac{7}{8}$ inch, but for stores, factories, and public buildings $1\frac{1}{8}$-inch or $1\frac{1}{2}$-inch stock is advisable.

Stock. Spruce and pine floorings are carried in two grades—first and second quality. First quality is free from knots, while second quality has small and tight knots.

Hard-pine flooring is rated as rift, quarter-sawed, first and second clear, and star. Only rift hard pine should be used for a good floor, as slash boards split and sliver. Oak flooring should always be quarter-sawed, and this, as well as all other hard woods should be in narrow widths, $2\frac{1}{4}$ inches being as wide as should be used for the best floors. First-class flooring is usually grooved on the under side to lie close to the rough floor, and should be matched and blind-nailed for good work. For offices and factories square-edged boards wear better and permit renewal more easily than does matched flooring. Floors laid diagonally or across the under flooring lie more smoothly and remain closer than if laid the same way as the under floor. If the added stiffness is desired for mill floors and it is not convenient to lay the floor diagonally, a degree of stiffness may be gained by laying the floor square and nailing it in diagonal rows.

Paper and Deadening. Between the upper and under floors paper should be laid, and a deadening of plaster, quilt, or mineral wool may be used. For mill and factory floors it is desirable to use two or three thicknesses of paper, mopped with tar or asphalt.

TILING

Preparation of Floors. Where the upper floor in wooden construction is to be of tiling or mosaic, special preparation is needed to obtain a thick bed of concrete or bricks under the tiles. To do this the rough floor must be let down between the timbers, and supported by strips nailed to the sides of the floor beams, as shown in Fig. 217. A bed of at least 4 inches should be provided, and the beams cut off to a bevel on top as shown. Even then there is a tendency for the tiles or mosaic to develop a crack over the beams, and so metal lathing is often used to prevent the concrete bed from cracking. This preparation is necessary for old floors which are to be tiled, or for new floors only a portion of which is to be covered with tile; but when the whole of a new floor is to be tiled, and there is nothing to prevent, it is better to set the floor timbers enough below the finished level to give the required bed, Fig. 218. Narrow boards should be used, laid $\frac{1}{8}$ inch open to allow for swelling. To prevent the moisture in the concrete from being absorbed too quickly by the boarding, and to guard against dripping, two thicknesses of tarred paper may be spread over the whole surface of the floor before the bed is laid; sometimes the use of corrugated metal lathing is advisable.

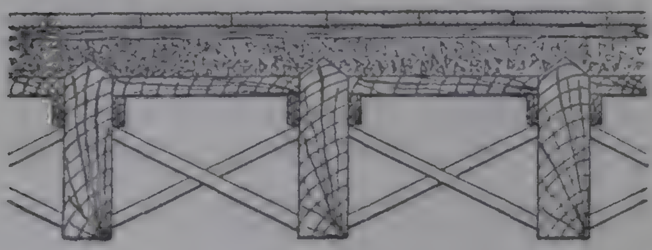


Fig. 217. Old Floor Prepared for Tiling

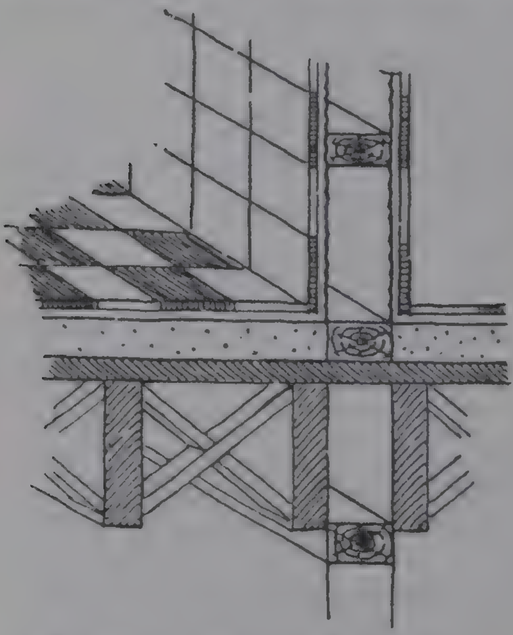


Fig. 218. Floor and Wall Tiling

The preparation of wooden walls for tiling is more simple. Here it is only necessary to provide a firm and continuous sheet of plaster upon which the tiles are to be bedded. This may be done by cutting in between the studs horizontal pieces 2 inches by the width of the studding and about a foot apart, upon which metal lathing is nailed; a rough layer of cement mortar (use hair in the mortar) is spread upon this, with room allowed for the proper bedding of the tiles, Fig. 218.

Laying Tile. Tiles of various patterns and materials are used to a large extent for floors and walls of bathrooms, corridors, and counting rooms. For fireplaces, and walls and floors of bathrooms, where the tiles are not subjected to hard wear, a plain glazed tile makes a clean and satisfactory job, but where much wear will come, the hard, vitreous, unglazed tiles give a better wearing surface.

The foundation for tiles should be prepared from the best Portland cement; it should be perfectly level and allowed to harden thoroughly before the tiles are laid. The foundation for both floor and wall tiles should be carefully brushed, to remove all dust and other foreign substance, and then well wet before the cement bedding is applied. Portland cement should be used for setting floor or wall tiles, and for grouting the floors, and the best Keene's cement for filling the joints in wall tiling. Clean sharp sand, well screened, should be used in equal parts with the cement for floors, and with 2 parts sand to 1 of cement for walls. The tiles must be thoroughly soaked in water before setting.

Floor tiles are set by being firmly pressed into the mortar bed and then tamped until perfectly level. When the bed is sufficiently set, the joints are grouted with pure cement and cleaned off with sawdust or fine shavings.

Wall tiles are set by two methods, called *floating* and *buttering*. In floating the tiles, a portion of the bed is spread on the wall, and the tiles placed in position and tamped until firmly united. Buttering consists in spreading the mortar on the back of each tile, which is then placed against the prepared wall and tapped gently until it is united with the bed. When the tiles are all set, by either process, the joints are carefully washed out and filled with cement. When fixtures are to be secured to the walls, as for plumbing, etc., a wooden piece should be fastened to the wall, flush with the rough bed, and the tiles laid over it, to be bored for the fastenings.

Mosaic Tiles. These are small tiles of various patterns adapted to laying in special designs or borders, and for this purpose are mounted on sheets of paper of a size convenient to handle. In setting the mosaic tiles, the sheets should be first examined to see that the design is right. The sheets are then laid carefully on the mortar, with paper side up. After the space is covered, the tiles are pressed into the bed, being beaten down with a block and hammer until the mortar in the joints is visible through the paper, without, however, breaking it.

In laying the sheets, care should be taken that the joints between the sheets are spaced the same as those upon the sheets, or the uniform effect of the floor will be spoiled. In large areas every third or fourth row of blocks should be set to a chalk line to preserve the straight line of the tiles.

After being laid the paper is moistened, and when thoroughly soaked it can be easily removed. When the paper has been removed, the tile should be sprinkled with white sand, before finishing the beating, so that the softened paste will not cause the tiles to adhere to the block. The whole surface is then brought to a perfect level. When the floor is leveled, the joints are filled with clean Portland cement mixed with water and forced in with a flat trowel, the surplus cement being removed from the surface by drawing a wet piece of Canton flannel over it. After the cleaning, the floor should be allowed to stand for a day or two, and then it is rubbed with sharp sand and a board of soft lumber to remove every trace of cement on the surface.

Protection of New Floor. All floor tiles should be protected for several days after being laid, and if it is necessary to walk upon them, this protection should consist of a heavy coat of sawdust upon which boards are placed. A white scum sometimes appears upon the surface of colored tiles, due to the cement. This can generally be removed by careful washing with soap and water. If washing does not remove the scum or the dirt, a dilute solution of muriatic acid (6 ounces of acid to a bucket of water) may be applied with a scrubbing brush and allowed to remain on the floor for a few minutes only, when it should be thoroughly washed off.

COMPOSITION AND LINOLEUM

If something other than wood is desired, floors of composition or linoleum may be applied either to the structural concrete floor or to a wooden floor surface. Composition floors having a base of cork, asbestos, asphalt, or other suitable medium, are laid in plastic form, usually from $\frac{1}{2}$ to $\frac{3}{4}$ inch in thickness over new or old floors, making a continuous covering. The principal requisites are that the floor shall be fireproof, resilient, non-slippery, quiet, and durable. Installation is generally made in two layers, the first one of a softer material, the top one hardened for a wearing surface.

Method of Laying. Composition flooring does not adhere to wet concrete and should not be applied until the rough floor is bone-dry, nor unless the building can be heated to approximately 70 degrees. The floors must be left by the contractor in a finished and polished condition and they should be given the same care and attention as a first-class hardwood floor; like hardwood floors, also, the laying of the composition floors should be deferred as long as possible in the finishing of the building. They should be carefully protected when first laid and should not be given any hard usage until thoroughly cured. This requires, according to the condition of the building, from 3 to 5 days.

Colors. The colors which have been found best adapted to composition flooring are rather few in number; red, buff, black, and gray are the staple colors which the manufacturers seem willing to guarantee not to fade, although green is used with a varying degree of success. These colors can, of course, be laid in combinations to suit the fancy.

Flooring Made in Units. There is another form of composition flooring which consists of slabs, or units, made up in square, oblong, and other shapes, some interlocking by joint or pattern. These tiles are usually $\frac{1}{4}$ inch in thickness and are laid in a waterproof cement made specially for this purpose.

Rubber Tiling. Rubber tiling, usually in an interlocking pattern, Fig. 219, is laid in a similar manner and makes a very durable floor, the resiliency of the rubber preventing a great degree of wear, while the elasticity insures it against cracking. All of these made-up floors are provided with a coved or sanitary base, if desired, and they are all adapted for use on stair treads and other places which are subjected to extreme wear.

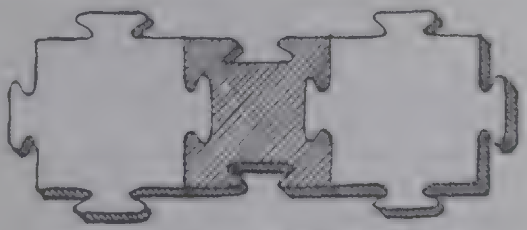


Fig. 219. Rubber Tiling of Interlocking Pattern

Use in Dwellings. Composition flooring of the same nature as that described for office buildings may be used to advantage for the service parts of a dwelling house. In selecting a floor of this kind for a dwelling, certain qualifications which are not of great importance in office floors should be well looked into; not only the wearing qualities, but imperviousness to heat, cold, and moisture, elasticity for foot comfort, ease of renewal or repair, besides weight and fire-resisting qualities, should all be considered, and—by no means the least important—appearance and ease of care. The plastic or monolithic type is to be preferred. If a wainscot or high base of the same material is required, this must be taken into account, and the proper spacing of studs and other requirements attended to by the superintendent. It will be necessary to see that unhampered facilities are given the workmen to apply the flooring evenly and continuously, and that ample time is allowed for the floor to harden, before it is walked upon or otherwise tested. Linoleum may also, if preferred, be used to good advantage on such floors.

WOOD-BLOCK FLOORS

Description of Blocks. For heavy warehouses, basements, stables, etc., a good wearing floor is obtained by laying wood blocks similar to street paving blocks. These blocks are made in rectangular or hexagonal shape, thoroughly shrunk, and impregnated with creosote or some similar preservative. The rectangular blocks are sometimes made with V-shaped lugs in projections on one end and side, running with the grain of the block and projecting about $\frac{1}{4}$ inch. This lug is of advantage in defining the joints and also in taking up any expansion from the swelling by the V-shaped edge, which will become compressed and not exert a thrust upon the walls of the building.

Method of Laying. The blocks are usually from $2\frac{1}{2}$ to 4 inches in depth (parallel to the fiber) and in random lengths, from 6 to 10 inches, and they should be laid over a concrete bed, on a cushion of sand about $\frac{1}{2}$ inch in thickness. After eight or ten rows of blocks have been placed, breaking joints, a plank is laid along the edge of the course and the blocks driven tightly together, the process being repeated as the laying of the floor progresses.

When a reasonable amount of floor has been laid, the blocks are tamped to a true and level surface and the joints filled about one-half full with sharp sand. A bituminous cement is then poured on and "squeeged" into the joints until they are completely filled. A sifting of dry sand should then be spread over the surface of the blocks to prevent sticking. If too much cement is found adhering to the surface of the blocks, it may be removed by applying coarse heated sand to the surface, the whole being then scraped off and the blocks left clean.

SPECIAL FEATURES OF OFFICE BUILDING CONSTRUCTION

Counters. For banking rooms and corporation offices, counters of greater or less extent and elaboration will be required. These are often made of wood but they may be constructed of other materials, a wooden top being sometimes preferred. Enameled bricks or tiles for the base of counters with wooden tops make a solid structure, while polished marble of almost any cost may be used. Where there is danger of a marble top being spattered with ink, a plate glass top, either clear or opaque, is often put over the marble, and in some cases, especially in the public portion of banking houses, sheets of heavy plate glass supported on metal frames are used. In the case of glass tops where coins are to be passed, the glass should be arranged so that the portion where the coins are passed can be easily replaced, as it will soon become scratched and present a bad appearance. Clear plate glass supported on a light metal base makes a good counter for rooms which are somewhat small, as it appears so much less bulky than a solid counter.

Grille Work. An important feature of a modern building is the grille work made of various metals and used for protection and decoration.

Exterior Grilles. For exterior ornament or protection, grilles will be found principally in door or window openings, and in this application, wrought-iron grilles are generally used. Window grilles are usually set in the depth of the stone or brick jamb of the window, as in Fig. 220, but they are sometimes put over the opening on the outside face of the wall. This is the customary way if the window is small, Fig. 221. The fastenings of grilles should be secure and lasting; and the grilles should be set in a rim of iron with

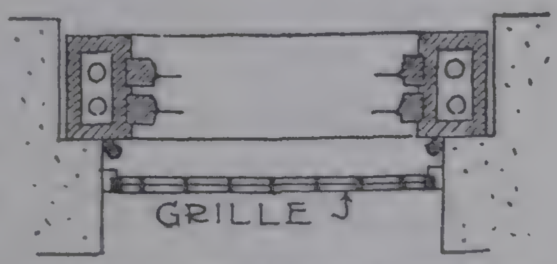


Fig. 220. Section Showing Usual Position of Window Grille

hinges and locks, to give easy access for cleaning the windows, Fig. 222.

Door grilles are sometimes glazed on the back with plate glass, to form a weatherproof door having the effect of the grille; when this is to be done, care must be taken to bed the glass carefully, as the expansion and the jar of closing are likely to crack it.

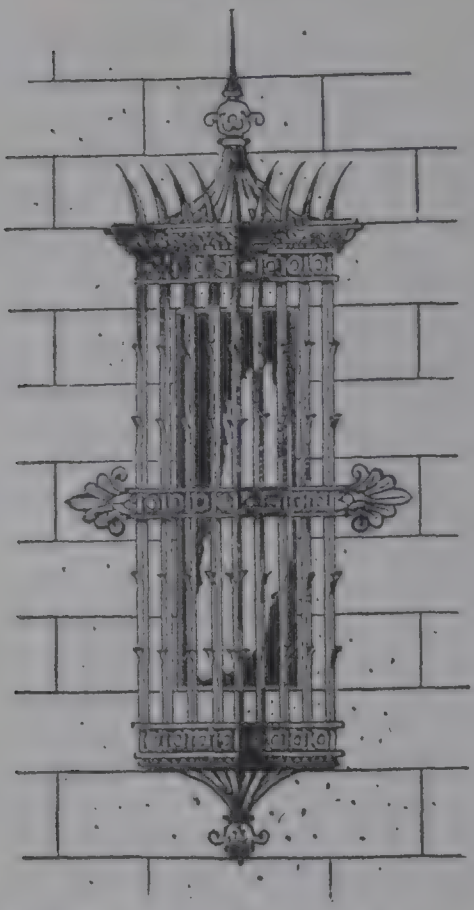


Fig. 221. Grille Outside of Window

Interior Grilles. Interior grilles are used chiefly in the protection of elevators or lifts, and to exclude the public from the working portions of offices and banks. Elevator grilles are generally made of wrought iron, and they should be at least 7 feet 6 inches high on the sides and carried from floor to ceiling in front of the doors of the car. All portions within easy reach of the public, where there is danger that the hand might pass through, to be injured by the moving parts of the elevator or counterweight, should be of a fine pattern or protected by fine netting. The main support of the grilles is found in the corner posts which support the elevators, or the stairs which often enclose them on three sides, and the pattern of the grille work should be stout enough to stand rigid between these posts.

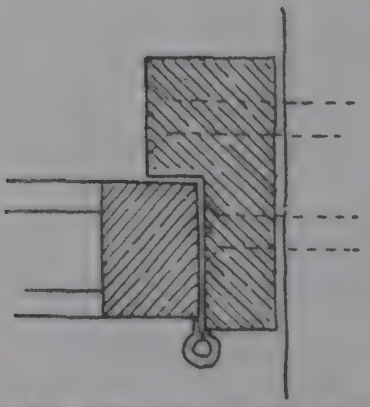


Fig. 222. Section Showing Hinging of Grille

The counter and office grilles are often made of thin steel, bent into various patterns and riveted together, a method of construction also used for elevator cars where lightness is a valuable feature. These grilles are finished by plating with copper, bronze, nickel, or other metal, and can be given almost any desired tone. Although these do not compare in appearance with wrought-iron grilles, they are less expensive, and more quickly made, and are readily obtainable from the manufacturers in a variety of stock patterns.

Wrought-iron grille work of all kinds should be carefully inspected to see that the scrolls are well turned, that welding or riveting is neatly done, and that the whole section is tightly put together. Cast-iron patterns must be inspected for smoothness and clearness of the ornamental sections, and an even thickness of metal should be required for all similar parts.

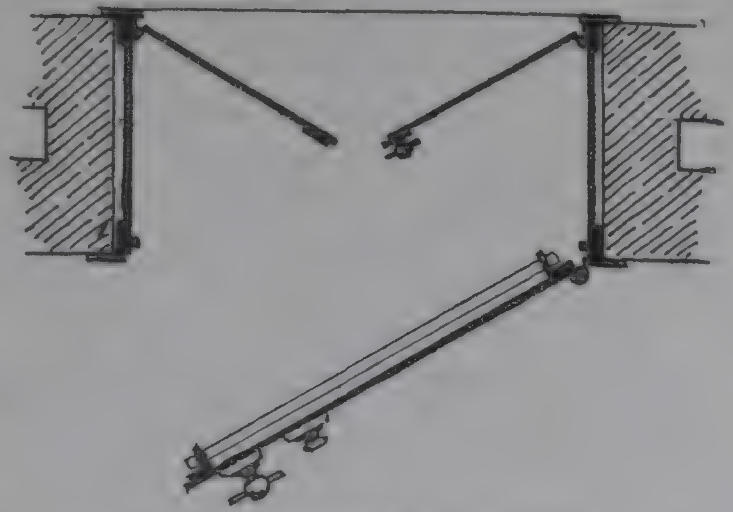


Fig. 223. Door of Fireproof Vault

Fireproof Vaults. All banking and large commercial offices require a fireproof vault of some sort for the preservation of valuable records as well as money. These vaults, in a building of ordinary construction, are easily made of bricks and steel beams. The vault, in principle, consists of a thick wall of bricks with proper air space and covering, enclosing a space of greater or less extent, access to which is given by a double set of doors, separated by the width of the wall at least, and securely fastened from without. To withstand the effect of a conflagration, the walls should be double, having an inner wall of 8 inches of brick, then an air space of 4 inches, and an outer wall of at least 8 inches of brick, both walls being tied together across the air space, which should be ventilated top and bottom. This gives a wall 20 inches in thickness and allows a door to be made with the outer valve in one leaf and the inner door in two parts, these parts opening into a vestibule formed in the thickness of the wall, Fig. 223. The top must be covered with bricks laid on iron bars or beams, and must be at least 20 inches thick to withstand the heat and the falling of beams or masonry, Fig. 224.

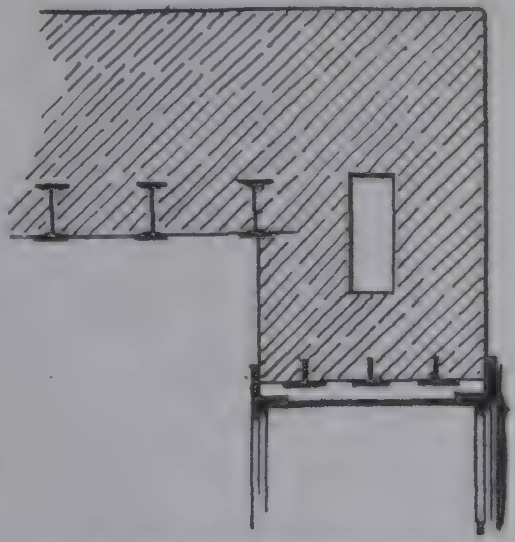


Fig. 224. Top Construction for Fireproof Vault

Burglar-Proof Construction. Vaults of this construction are fireproof but not burglar-proof, the latter advantage being obtained by a lining of chilled steel or a separate burglar-proof safe set within the brick vault. Vaults have also been made burglar-proof by constructing them of concrete in which are imbedded enough old iron or steel bars or rods, to make it a slow and difficult process to effect an entrance of sufficient size to extract any part of the contents. Copper wires are sometimes laid in the concrete at intervals of 3 inches or less, connected with a battery which rings an alarm bell if the wires are tampered with.

Store Windows. The present-day desire to have as much plate glass as possible in store windows has led to the development of a special construction, with the object of reducing the necessary supports of the glass to a minimum. For ordinary store windows, where the lights are not more than 6 feet wide, the bars may be made of a common T-bar covered by a half-round of nickel-plated brass over a wooden form, *A*, Fig. 225, the glass being set from the inside, and held in by pins and putty or wooden stop beads. Sometimes a half-round bar is screwed to a web piece of iron, and the outside painted or covered with nickeled brass, as at *B*, Fig. 225. Another form giving greater strength of web is shown at *C*.

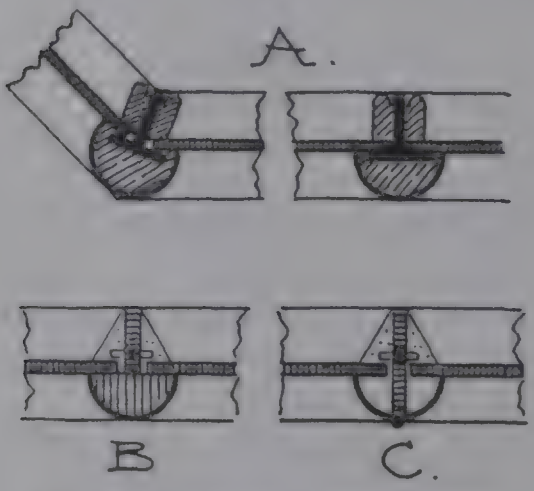


Fig. 225. Sections of Special Sash for Ordinary Store Windows

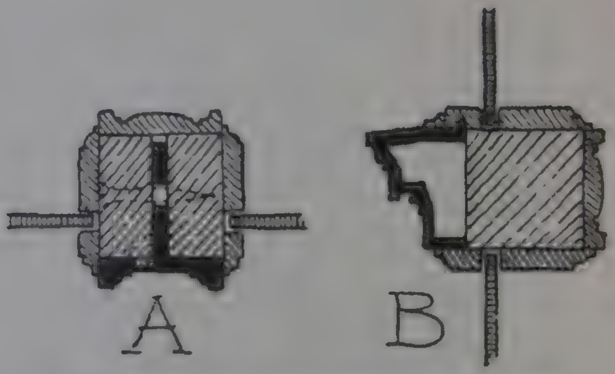


Fig. 226. Section of Window Bars for Large Plate Glass Windows

For larger lights, a special method which will give greater strength is required; this is often secured by means of a special casting exposed and ornamented on the front, but otherwise concealed in the wood finish, as at *A*, Fig. 226. These castings should be about 2½ inches wide by 3 inches deep, depending upon the size of the glass, and the glass may be set either from the outside or the inside, and held in place by molded stops, made of metal on the outside, if desired. If transoms are used, they may be of the same section as any of the bars, or a more ornamental form may be given, *B*, Fig. 226.

The top of the window usually has the same section as the sides, and the sill depends upon the character of the show window and whether or not the sash comes to the floor. If a bulkhead is required with cellar lights under it, a section similar to that shown in Fig. 227 is often employed. To prevent the windows from becoming frosty in cold weather, ventilating openings, through which the condensation may drain out, are provided, and also a trough to connect with these openings. Basement sashes should have wooden sills fitted over a lip in the iron or concrete of the sidewalk, or bedded tight if the sidewalk is of stone or brick.

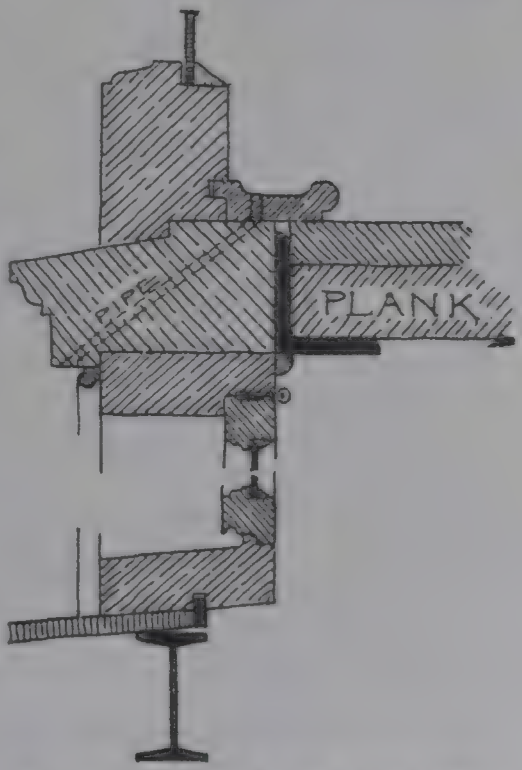


Fig. 227. Section of Sill of Store Sash

The corners of store windows may be treated by adapting any form of bar to the angle, and where it is of advantage to show no bar at all, the two sheets of glass coming together at an angle may be made to support each other by clamping them together with no dividing bar. Several patented forms of connection may be used for this, as well as for the dividing bars. In setting large lights of plate glass, a backing of rubber or leather should be used in place of the usual back puttying.

Sidewalk Lights. It often happens that space under the sidewalk is needed to add to the area of the basements, and this is usually permitted by city ordinances. Then the question of introducing daylight comes under consideration. Many types of sidewalk or vault lights may be obtained, differing as to support, form, and glazing, and running from the original type of round bull's-eyes set in a cast-iron plate to the most modern construction of composite nature. The principal features to be considered are admission of light, exclusion of water, and minimum of breakage, the breakage being generally caused by accident, poor glass, expansion or vibration of the construction, or pressure from the street adjoining.

The ideal light is consequently a strong glass of good size set in a construction that combines elasticity with rigidity against outside pressure. This is best obtained by the use of concrete and steel, in some one of the many forms now on the market, which differ from each other mainly in the shape of the glass, the method of reinforcement, and the ease of setting or replacing the glass in case of accident.

As between square or round glass, it is well to remember that while the square glass gives a comparatively greater light area, the round glass is in many cases more easily replaced, and this in some situations is an important feature. The accidental breaking of a glass cannot be avoided, but to guard against general breakage, some one of the systems that provide for expansion or afford a protective cushion for the glass is well worth considering.

Prismatic Glass. For the better lighting of deep interiors or places where the available supply of direct light is limited or distorted, prismatic glass is to be recommended. This glass comes in sheet form or in the shape of tiles, usually set in a metal rim or sash. The effective use of prismatic glass requires that each job shall be treated scientifically in accordance with its needs, a haphazard installation being productive of waste and dissatisfaction.

For a successful result, a careful study is made of existing sky conditions, and prisms of a correct angle properly to diffuse or concentrate the light are put in place. In cases where the visible sky area is limited, as at the bottom of shafts or light areas, it is often necessary to install a canopy of prisms, projecting from the wall at a correct angle and containing prisms having the proper degree of refraction to throw the almost vertical rays into the room. This situation is one of the most difficult to contend with; a deep building having a broad exposure to unobstructed daylight requires simply the refraction necessary to change the direction of the normal oblique rays to a more horizontal and penetrating angle.

As to the choice between sheet prisms and the so-called tile prisms, the advantage in appearance rests with the tiles or quarries, while in the matter of cost the sheet glass has the advantage. The small lights in metal setting produce a fire-resisting screen, while with large lights the type known as wire glass, which has a wire mesh imbedded in the plate, meets the usual fireproof requirements.

Another use of prismatic glass is found in sidewalk lights, but these are of a special type and are generally found in the form of a single prism as distinguished from what is generally called prismatic glass.

Revolving Doors. For stores or public buildings where the passing of adults is steady but not excessive, it may be well to install revolving doors as a protection against the cold. These consist of a turnstile arrangement of doors, having three or more wings, built in a vestibule with curved sides and so adjusted that at least two of the wings make a continuous barrier from one side of the vestibule to the other, Fig. 228.

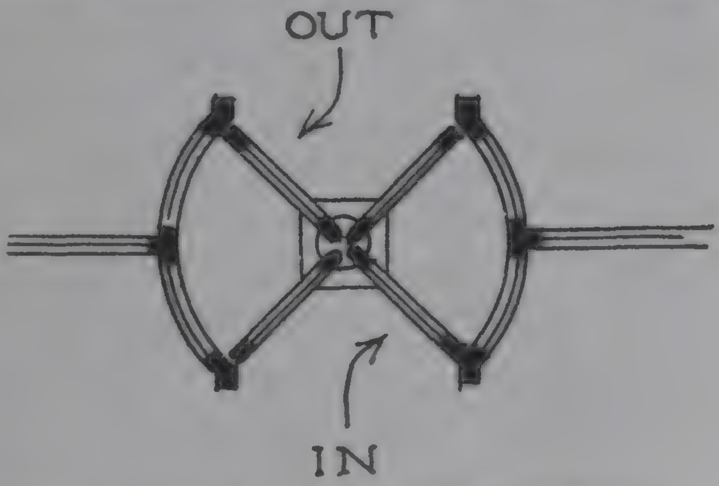


Fig. 228. Section of Revolving Store-Doors

Wherever used, the doors should be of the automatic panic-proof type in which the revolving wings are so arranged that a pressure slightly more than is required to revolve the doors, when applied to any part of any two of the wings, will cause them instantly and automatically to collapse and fold outward. The wings should also be built so that they can be collapsed and moved to one side to give free passage in mild weather, or locked across the vestibule for security. Where the doors come in contact with the walls of the vestibule they should be provided with ample flexible strips to prevent injury to the hand or person.

Mail Chutes. For the convenience of the occupants of offices above the first floor, any office building of size should have the system of mailing letters by means of a specially constructed chute connected with the mail box at the bottom. The location of the chute should be determined early in the course of construction and preparation made for it. The system, which is patented, must be installed subject to the approval of the local postmaster, and all the apparatus, when erected and accepted by the Post Office Department, passes under the care and control of the government, which authorizes the locks and boxes. The boxes are of various sizes and patterns, and are furnished by the makers of the chutes. Government regulations require that the chutes be in movable sections, exposed to view and easily accessible, and stipulate that they may be run only in the public hall or corridors of a building. The chute must be made of metal with a plate glass front, clearly marked with the insignia of the department; when so installed it is technically a part of the mail box below.

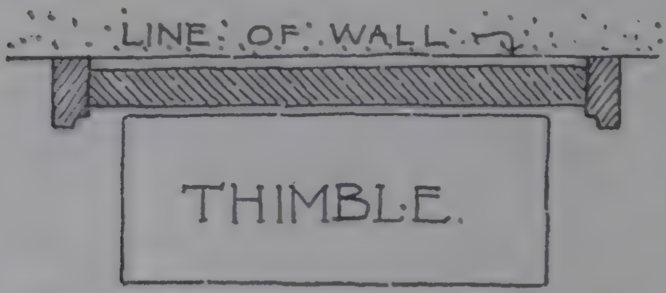


Fig. 229. Backing of Mail Chute against Wall

The requirements for the support of the chutes are a continuous vertical surface $10\frac{1}{2}$ inches or more in width, carried from the box below to a point not less than 4 feet 6 inches above the top of the highest floor to be supplied. In front of this vertical run must be set the iron thimbles provided by the makers, $3\frac{5}{8}$ inches by 9 inches, the whole absolutely plumb, with no bends or offsets anywhere.

For wooden buildings a flat casing of wood may be used, or marble or other costly material may be substituted, wholly or in part. This construction is generally used where the chute runs against a wall, as in Fig. 229. Where the chute runs down beside an elevator grille, or in other places in which a solid back would be objectionable, two "square root" angle irons are generally used, turned so as to give an even backing, Fig. 230, the thimble in all cases being the same, and the angle irons being secured to the floor beams or other rigid support.

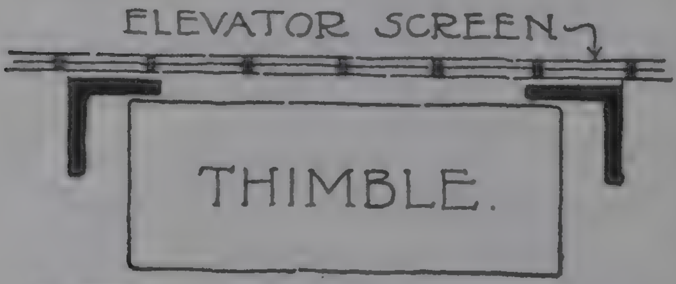


Fig. 230. Backing of Mail Chute against Grille

This preparation may be made a part of the building contract or of the mail chute contract; in either case it will have to be done to the satisfaction and acceptance of the makers of the chutes and of the local Post Office authorities.

FIREPROOF BUILDING

IMPORTANT QUESTIONS FOR PRELIMINARY STUDY

The most modern features of city building construction are the high business blocks which form the main part of the commercial districts of all cities. In the erection of these buildings a variety of problems present themselves, more or less complicated according to the nature of site and surroundings, of size, and of usage.

Land Values. In the first place, the value of the land which the proposed building will occupy must be considered. Real estate in the heart of our large cities attains almost fabulous value, and the first demand which the owner will make, will be the maximum of rentable area within the walls of his building. This of itself will force us to adopt a system of construction which will permit the thinnest walls that safety justifies and the building laws allow, and the same consideration will force us to build as high as possible. From these tendencies has arisen the modern skyscraper, a construction consisting of a steel skeleton, covered with masonry simply as a protection for the steel and for the contents of the building, and having no weight-bearing value in itself. The floors and walls are supported wholly by the steel frame, which is carried usually on isolated supports far below the sidewalk. This is the common form of high building and is known as skeleton construction.

This type of construction is fully treated in Part III, so that mention need be made here of only some important details which affect mercantile buildings in relation to the general layout of the plan.

Height of Buildings. As the owner will naturally desire to obtain as many floors as possible, it will be necessary to consult, first of all, the building laws of the city in which the structure is to be erected, to determine the height to which the building may be carried. This determined, the number of floors must be decided. As the lower floors are less likely to be subdivided than the others, they must be given a height which will be in proportion to the probable size of the rooms; the height of the lower stories must, therefore, be added together, and the sum, with the addition of the thickness of the floors, must be taken from the whole height of the building before we can establish a unit of height for the remaining stories.

Building Site. While these matters are under consideration by the owner, an examination of the proposed site will be profitable, to gain necessary information with regard to party walls and the condition of adjoining property. The nature of the soil and the location of sewers and other underground works, will be factors in the proposed construction, and all data relating to these matters must be recorded and carefully preserved.

General Construction Problems. *Vertical Supports.* As soon as the instructions of the owners, or the recommendations of the architect, have been definitely adopted, the construction of the building will be laid out. Certain factors, which do not enter so strongly into the problems we have previously studied, must have careful attention in constructing mercantile buildings of this class, and upon our skilful management of them will depend the success of the enterprise.

As the problem will resolve itself into the disposition of a greater or less number of isolated points of support, instead of the ordinary continuity of walls, it will be necessary to study the construction at the same time with the laying-out of the offices in order to place the necessary vertical supports as much out of the way as possible.

Thickness of Floors. Another matter of importance will be the thickness of the floors. Since the number of floors is certain to be considerable, it will be readily seen that an excessive thickness would result in an appreciable loss of height; if the thickness of each floor can be kept down to a reasonable rate, it may be the means of obtaining one more story for renting purposes, which is a matter worthy of consideration.

External Factors. In bringing together the elements to form a whole composition, certain external conditions must be taken into account. Among these are ease of access, maximum of light, rentable area, ease of rearrangement to suit tenants, and minimum of cost. Ease of access requires that the elevators and stairs shall be placed in direct and obvious connection with the entrances and as nearly as possible at the level of the sidewalk, that they may be readily seen on entering the building or on leaving the offices to which they lead. The position of the elevators is of more importance than the stairs, as the latter will be little used in high buildings. To obtain the best light possible it is well to provide that the areas (which are a necessity in a building in the interior of a block or in a wide building on a corner) shall have a general direction north and south. These areas should contain windows as large and as near the ceiling as possible, and the rooms should be as nearly rectangular as may be, to avoid dark corners.

The structural conditions determine more or less the arrangement of the offices, as already suggested, but the adjustment of the office space to the needs of the tenants is a matter that must also be given consideration. The unit of size and the arrangement of the offices should be such that the tenant who wants a single office may have one of average size, and the tenant who wishes may have a whole floor, except the minimum of space necessary for toilets, elevators, and stairs.

FLOOR CONSTRUCTION

When the character of the building and the general divisions of the floor space have been established, the location and design of the columns, the kind of wall and floor construction, and the size and spacing of floor beams and girders must be decided. The location of the columns and girders will be determined by the size and shape of the floors, the position of present or future partitions, the floor loads, and other considerations which arise with different locations and uses.

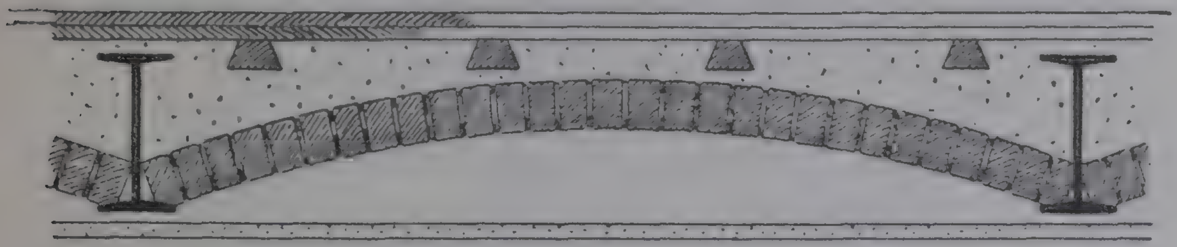


Fig. 231. Section Showing Typical Brick Floor Arch Construction

Original Fireproof Floor. The size and spacing of the floor beams will depend upon the style of floor construction which may be adopted. The original fireproof floor construction consists in spacing beams 5 or 6 feet apart, and turning a brick arch from flange to flange of the beams, Fig. 231. The space above the arch is filled with concrete up to about an inch above the beams, completely enclosing the steel; and screeds, running parallel to the beams and bedded in the concrete, give a sufficient nailing for the floor boards. The ceiling underneath may be finished by simply plastering on the underside of the brick arch, or a level ceiling may be hung to the rough floor. As an arch of such a shape will exert considerable thrust, this must be taken up by the use of tie rods $\frac{5}{8}$ inch or $\frac{3}{4}$ inch in diameter, spaced along below the center line of beams at intervals of about 6 feet. This style of flooring weighs about 70 pounds to the foot, and has been practically superseded by the lighter constructions employing terra cotta arches or concrete.

Terra Cotta Floor Arches. Hollow terra cotta blocks, molded in the form of a flat arch, are used to a large extent for fireproof floors, and are to be obtained in a variety of patterns and devices. These various patterns may be divided into two principal classes according to the method of laying—the side method and the end method.

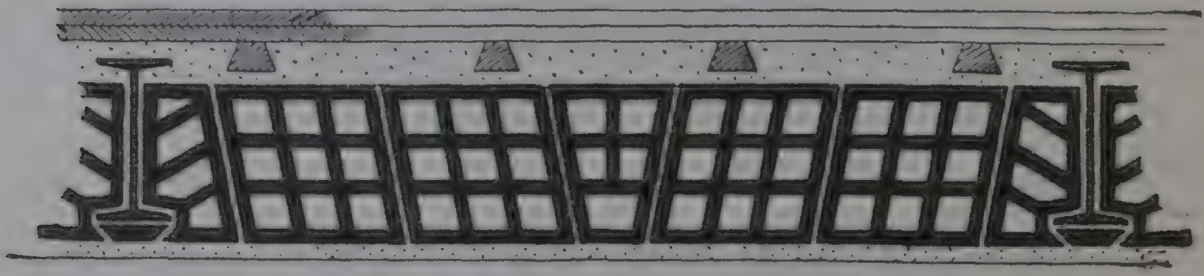


Fig. 232. Section Showing Side Method Terra Cotta Arch Construction

Side Method. The side-method arch, where the blocks are laid with the webs parallel to the beams, Fig. 232, is the original form of terra cotta floor arch, while the end-method, where the blocks are laid end to end at right angles to the beams, is an improvement designed to present the full end-section of the material to resist the great thrust of the arches. These side-method arches are usually made of dense terra cotta and may be obtained of various depths from 6 to 15 inches; they should be set with close joints and thoroughly cemented together. Specially molded blocks, called skewbacks, are made to fit the lower flanges of the beams and project about 2 inches below the beam, which is covered by a thin strip of tile. The space above the blocks is filled with a cinder concrete, in which beveled wooden strips are imbedded as a nailing for the wooden floors.

Side-method arches are made to break joints endways, so as to give a bond; and they are usually strong enough for all ordinary floor loads. The joints in the blocks are generally made parallel to the sides of the key block, as this gives a uniform pattern and so is less expensive than a radial jointing; the latter makes a stronger arch, but on account of the expense of making and adjusting the different patterns, it is little used.

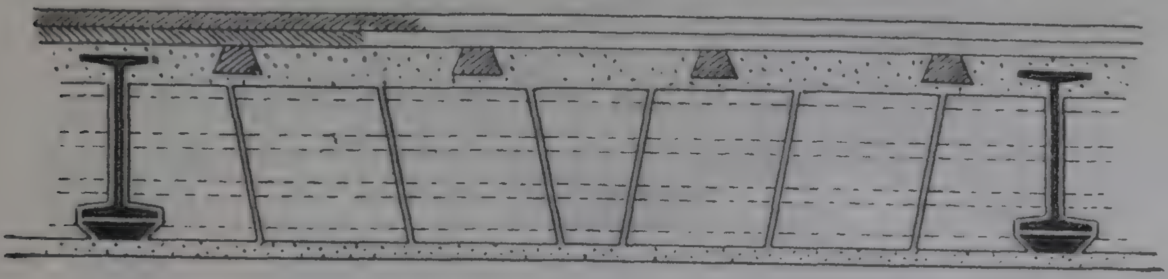


Fig. 233. Section Showing End Method Terra Cotta Arch Construction

End Method. In this method, the blocks are usually made of porous terra cotta and are set end to end, giving greater resistance to the thrust by forming a series of continuous webs from beam to beam, Fig. 233. The blocks are generally set in continuous lines, not breaking joints. The jointing of the tiles must be done with great care, as the open ends do not give so good a surface for cementing as do the tiles laid by the side method, and, the bearing on the beams being given by the thin webs, it is necessary that the joints be perfect.

Combination Method. Because of the difficulty in jointing, a combination method is often used, shown in Fig. 234. This gains the extra strength of the end blocks, and the better bearing of the flat skewbacks, the skewbacks being made with many webs and of small sections.

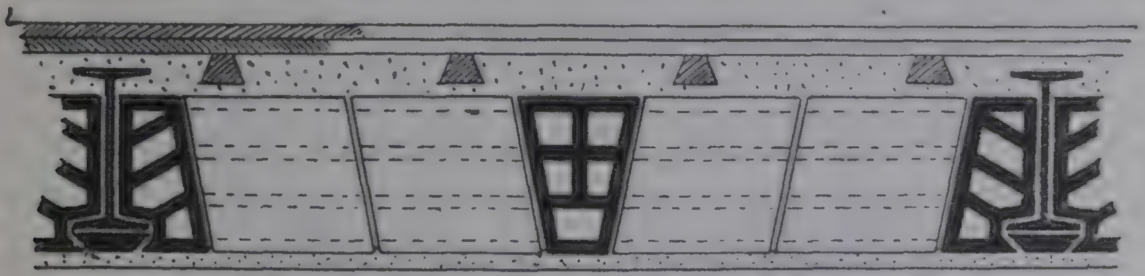


Fig. 234. Section Showing Combination Terra Cotta Arch

Setting. Floor tiles of either pattern must be set upon plank centers which are hung from the beams, and should be crowned $\frac{1}{4}$ inch in an arch of 6 feet. All joints must be close, and made with cement. The centering should be left in place until the cement is thoroughly set, which will require from twelve to thirty-six hours, according to the weather and the nature of the cement, and care must be taken that the freshly laid tiles are not too heavily loaded with materials until they are hard. If the arches are to be plastered upon for a ceiling, they must be kept clean, or bad stains are likely to appear. All holes or irregularities on the underside must be filled with cement mortar to give a proper surface for plastering. Where a flat ceiling is not required, but strength is the main factor to be observed, segmental tile arches are often used, Fig. 235, made with a rise of an inch to the foot, up to 20 feet of span. They are employed to a great extent in warehouse construction.

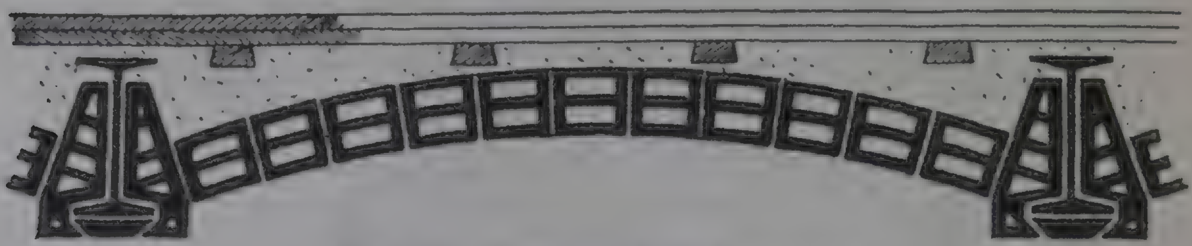


Fig. 235. Segmental Terra Cotta Arch

While the nature of floor tiles does not permit a fine joint to be made, they should be laid as closely as possible, especially the key blocks. Joints as great as a half-inch should not be permitted, and the tiles should be set in place by being shoved together as in brick laying. Unless the building is closed in, floor tiles cannot be laid in cold climates when there is danger of freezing and thawing, as the joints are likely to be affected to the extent of causing deflection, if not more serious trouble.

Floor arches are often tested by applying a heavy roller to them after the wood centers have been removed, and by dropping a heavy block of timber upon the arch, a 2-inch bed of sand being previously spread over the tiles to prevent mechanical damage.

Concrete Floors. The use of concrete for floors has become an important factor in the construction of fireproof buildings. Concrete floors combine the qualities of strength and ease of construction with lightness, and are less expensive than most of the hollow-

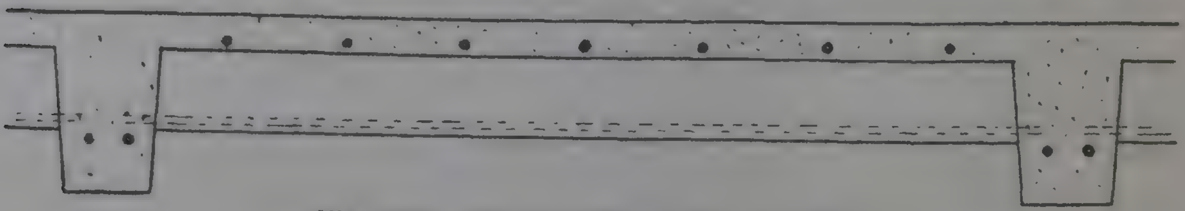


Fig. 236. Section of Heavy Ransome Floor

tile constructions. Concrete so used is generally found in combination with steel or iron in some form or other; it is to the reinforcing material that the concrete owes its tensile strength.

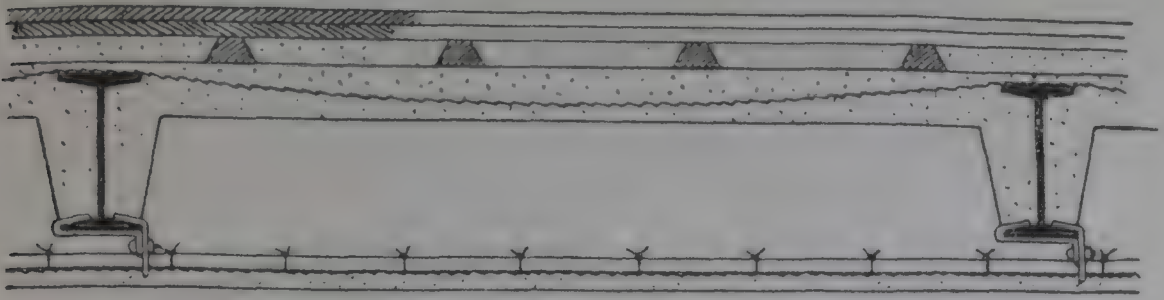


Fig. 237. Section of Expanded Metal Floor

Concrete floors may be considered under two principal classes, one in which the concrete in combination with steel tensile members forms the whole of the floor construction, Fig. 236, and the other in which steel I-beams are set as for brick or tiles, the spaces being filled in with concrete, either in the form of a plate, Fig. 237, or supported upon an openwork metal base, Fig. 238.

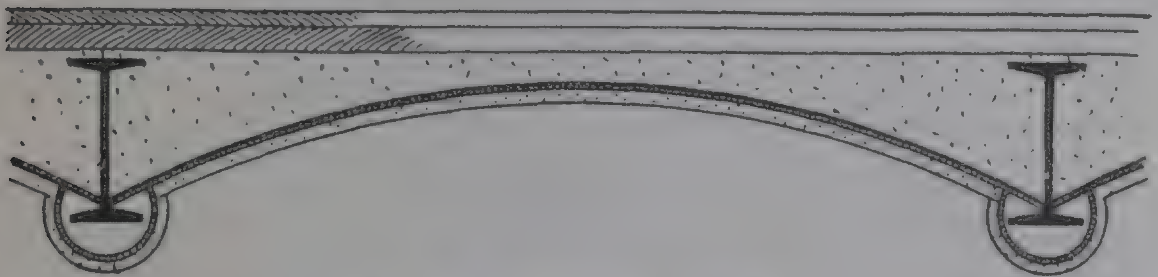


Fig. 238. Section of Roebling Floor

A newer type, which partakes of the characteristics of either or both of these forms, employs hollow forms of corrugated or perforated steel or of some plaster-holding composition so spaced as to divide the floor into a series of beams or panels made by the concrete filling which is poured between and over the hollow forms as centering, the forms shown in Fig. 239 remaining in place in the finished structure.

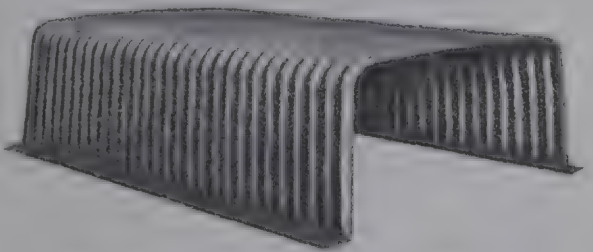


Fig. 239. Pressed Metal "Floretyle"

Various patented forms are used in this way so designed as to be adjustable to any length or width, and so arranged that, by spreading, different widths of beams may be obtained. These forms are called by various trade names such as "Ferro-Domes", "Flore-Domes", "Floretyles", etc.

Advantages of Different Types. With many types of flooring available, each possessing merits peculiar to its own construction, the architect is often at a loss to decide upon a special system. Cost, which is an ever-present factor, will decide in many cases, and in others local considerations may require particular methods. In the main, regard should be given to lightness, strength, and fire-resisting qualities, as well as to speed of erection and the skill of available workmen.

Of the respective merits of the two general systems of terra cotta and concrete, much has been written, especially with regard to fire-resisting qualities, but the question of the advantage of one over the other cannot be said to have been settled at the present time. For the very high buildings, one of the systems requiring the use of riveted steel floor beams and girders is usually adopted, the beams spaced not only with reference to the load and the requirements of the floor construction, but with a regard to the general strength and stability of the whole building.

Fireproofing. The various parts of a building of steel construction are in themselves of a fire-resisting character, but for the thorough protection of the structure, special devices must be employed.

Columns. Especially is this true in the case of columns, which must sustain great weight and should, therefore, be adequately protected. Columns may be enclosed in concrete or brick, which should be not less than 8 inches thick; or hollow terra cotta tiles may be used, preferably in two layers, each not less than 2 inches thick and breaking joints, Fig. 240. Columns may also be partially protected by the use of metal lathing and plaster in one or two layers with an air space between, Fig. 241.

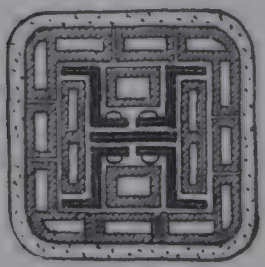


Fig. 240. Terra Cotta Column Casing

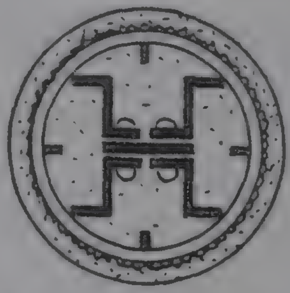


Fig. 241. Lath and Plaster Column Casing

Floors. Floor beams and girders are protected normally by the floor or ceiling construction, and each maker of floor construction has his own system of fireproofing for girders and columns and other exposed members, so that, in general, the contractor for the floors will be given a contract for all the other fireproofing in the building.

ROOF AND WALL CONSTRUCTION

Roofs and Ceilings. As the roofs of high buildings are generally made with very little pitch, the same construction may be used here as for the floors, but a special treatment will be required to retain a level ceiling in the upper story. This is usually done by hanging steel T-bars at a level below the roof, upon which a ceiling may be laid either of terra cotta blocks to be plastered, Fig. 242, or of metal lathing, Fig. 243.

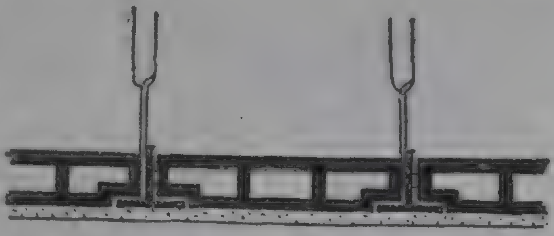


Fig. 242. Hanging of Terra Cotta Ceiling

Exterior Walls. The construction of the exterior skeleton of a fireproof building varies according to the covering material. While the adopted type of floors may be carried throughout one or several buildings, by a simple repetition of methods, the construction of the outside frame must be modified to suit the different materials used in different buildings, or often in different portions of the same building.

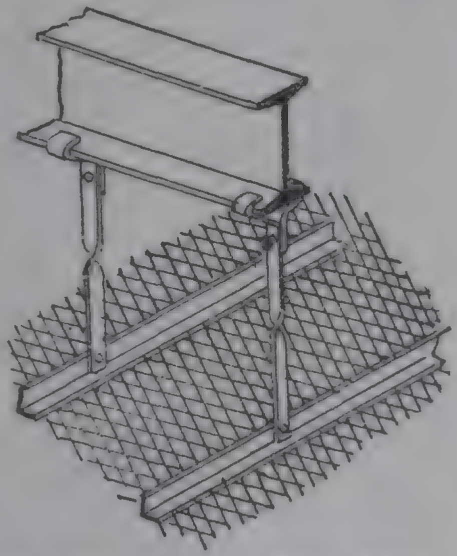


Fig. 243. Hanging of Wire Lath Ceiling

The exterior treatment of a building of skeleton construction may be said, in general, to resolve itself into a series of piers, more or less marked in character, which enclose the vertical supports, the space between them being to a great extent occupied by windows, while a horizontal piece of masonry separates the windows of each story and covers the floors.

The masonry enclosing the building is generally supported by the steel frame, and may be of brick or stone, according to design, though concrete and terra cotta in molded or cast forms are also available.

Terra Cotta Covering. The adaptability of terra cotta to the exterior adornment and fireproofing of buildings is so great that its use has become general in all places where durability and resistance to heat are essential. The ornamental facings cannot always be supported by direct bearing on the steel frame, and so a system of anchors and ties must be devised by which the separate blocks may be held in place.

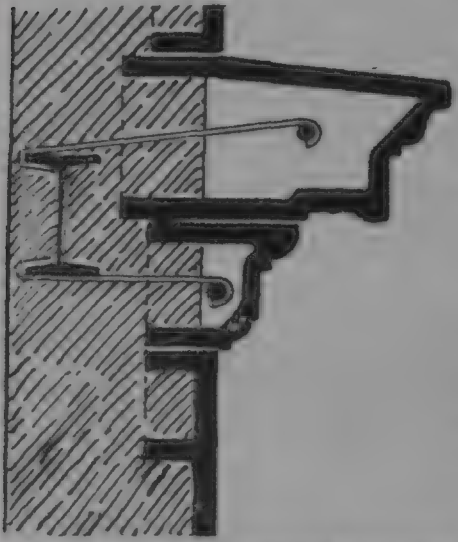


Fig. 244. Section Showing Method of Anchoring Terra Cotta

For terra cotta finish which has no great projection from the line of support, ties of $\frac{1}{4}$-inch rods may be hooked into the ribs of the terra cotta and secured to the steel frame or the brick filling, Fig. 244; but when a greater projection is required, as for cornices, then small beams or T-irons must be used, well built-in or anchored to the main structure, Fig. 245. Exterior terra cotta as ordinarily finished is not affected by the atmospheric conditions which affect stone; but as the surfaces are likely to become warped in the baking, it is necessary to see that no attempt is made to straighten bad pieces by chiseling, as this destroys the surface and exposes the softer interior to the danger of decay.

PARTITIONS

The partitions of fireproof buildings may be built of brick, terra cotta, tiles, or plaster blocks, or of light iron studding with metal lathing and plaster. Brick partitions, to resist the passage of fire, must be at least 12 inches thick, and are not, therefore, generally used unless required for floor bearing also. With the column and girder construction which we have had under consideration, a lighter construction than brick is generally desired for partitions.

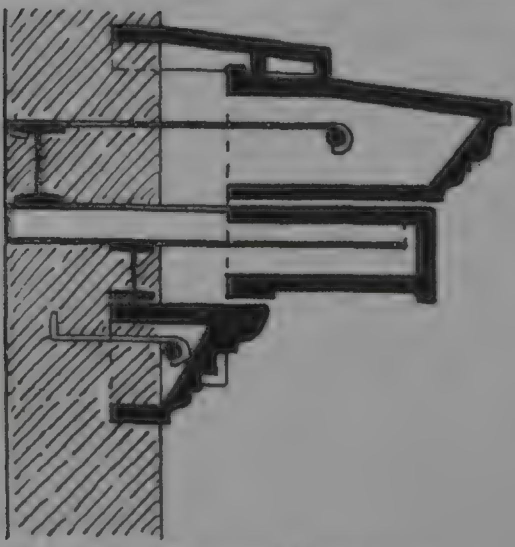


Fig. 245. Section of Terra Cotta Cornice

Partition Blocks. Terra cotta blocks, either of dense or porous terra cotta, make good partitions, Fig. 246; these are usually made 4 inches thick, and are of the same composition as the floor blocks. They are generally set with the hollows running horizontally, in order to obtain the flat surface for bedding, but where it is necessary to cut for vertical pipes, it is well to set a vertical line of blocks on end and clamp them to the flat tiles. All openings for doors and windows are made with wooden studs (or with steel bars, if the door frames are of cast iron) to receive the frames and finish. For thinner partitions, blocks of solid porous terra cotta 2 inches thick may be used, but they must be clamped or banded together. A patented partition may be obtained of thin terra cotta plates, reinforced by twisted steel wires run on either side of the plates and imbedded in the plaster. Thin plates having plaster of Paris for a base, and clamped or banded with iron, are also used for partition blocks where extra lightness is required.

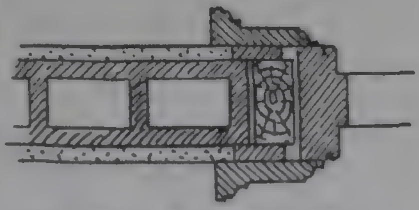


Fig. 246. Terra Cotta Bloc Partition

For all of these blocks, mortar composed of lime with a little cement should be used for setting, and the finished plaster surfaces are best when hard-setting plaster is used.

Metal-Lath Partitions. To save floor space, very thin partitions may be made by using small steel bars for studding; these are usually $\frac{3}{4}$-inch channel bars set vertically about a foot apart and turned at a right angle to be fastened top and bottom. On one side metal lathing is stretched and wired to the bars. This is covered with a very heavy coat of hard plaster, which squeezes through the lathing and makes a good surface to receive the plaster of the other side of the partition, the whole forming, when completed, a solid wall of plaster and metal about $1\frac{1}{2}$ inches thick, Fig. 247. It is necessary in this case to use a very hard-setting plaster, as this gives the partition its stiffness. Special patented studs of sheet steel, made with prongs to hold the lathing, and of various depths, Fig. 248, are used in a similar manner. Door and window frames are placed in these thin partitions by setting up a rough wooden frame to which the channel bar is screwed, as in Fig. 249, and as a nailing for chair rails, picture moldings, and other finish, strips of wood are laced to the lathing, flush with the plastering, before the plaster is applied, Fig. 250.

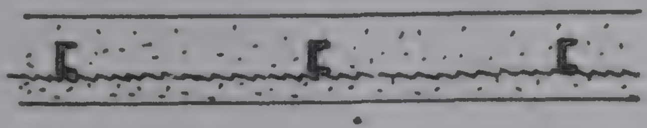


Fig. 247. Section of Steel and Lath Partition

Metal Lathing. Metal lathing, which is of great importance both for fireproofing, and for the finishing of fireproof buildings, may be obtained in a variety of patterns and devices.

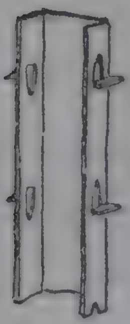


Fig. 248. Steel Stud

Wire Cloth. The original metal lathing was the common wire cloth, and this is still one of the principal forms in which it is found. Improvement in the manufacture of wire cloth has been made by stiffening the cloth in various ways by the use of rods or ribs of metal. These are attached to, or woven into, the lathing which is then known as *stiffened lathing*.

Clinton Lath. A well-known form of stiffened lathing is the Clinton lath, which contains corrugated steel furring strips, attached to the cloth by metal clips and running across the roll every 8 inches. These strips not only serve to stiffen the lathing when stretched over furrings, but, if the lathing is applied directly to a plain surface, such as planking or brick walls, the stiffening keeps the lathing away, and gives room for the clinch of the plaster.

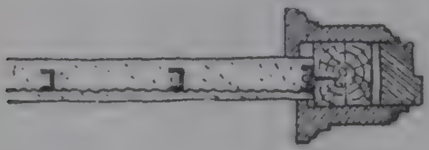


Fig. 249. Door Finish in Thin Partition

Roebling Lath. The Roebling stiffened lathing contains V-shaped ribs of various depth, which are woven into the cloth at 7½-inch intervals. These ribs serve for a furring, and are made from ⅜ to 1½ inches in depth. For special uses, ribs of ¼-inch steel rods are used instead of the V-shaped steel. Wire cloth for lathing is run in a variety of meshes, 3×3 and 2½×2½ to the inch being the common meshes, and they may be obtained plain, painted, or galvanized. Painted lathing is very satisfactory, and is more generally used than any other kind.

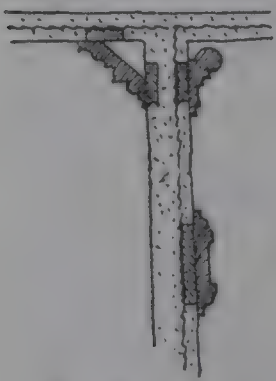


Fig. 250. Wood Furring in Thin Partition

Expanded-Metal Lath. This form of lathing is made from strips of thin and tough sheet steel, which are cut at regular intervals and then "expanded" by being wrenched or pushed into open meshes, large or small as the cuts are made long or short. This expanding also turns the metal on edge, making a flat and stiff sheet of lathing much larger than the original piece of metal, Fig. 251. Having a degree of stiffness, this lathing does not require stretching, and it is used extensively for wrapping steel beams or columns, for fireproofing or finishing, for thin partitions and for concrete floors.

Bostwick Sheet-Metal Lathing. An objection is sometimes made to wire or expanded-metal laths, because they require an excessive amount of plaster for ordinary uses. This may be overcome by the use, when feasible, of the Bostwick sheet-metal lath, shown in Fig. 252, which is made from sheet steel by punching out loops at regular intervals. In this, and in many other forms of sheet-metal lathing, the surface is corrugated, besides being punched, to give stiffness and to keep the lathing away from the surface to which it is applied. Sheet-metal lathing is especially adapted to the forming of coves or round corners, but for fireproofing, the open lathing, requiring a greater amount of plaster with the metal more thoroughly imbedded, is to be preferred.

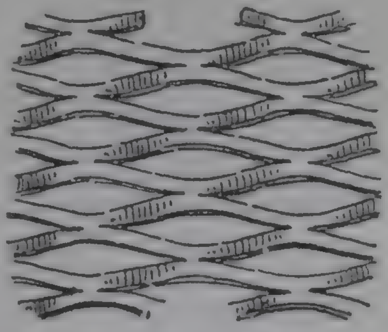


Fig. 251. Expanded Metal Lathing

Rib-Stiffened Lathing. Almost all manufacturers of expanded-metal lathing make some form of lath having ribs or stiffeners of different depths, some only enough to give a clinch to the plaster, others deep and stiff enough to give an amount of strength such that the material may be used for a light roof or partition without the usual joists or studding.

This method of stiffening or furring is more valuable to expanded or sheet-metal lathing than to wire lathing, inasmuch as it can be formed up integral with the lath, this producing great stiffness, if desired. This material is known to the trade as "Hy-rib", "Self-Sentering", "Corr-Mesh", or by some other title more or less descriptive of the product.

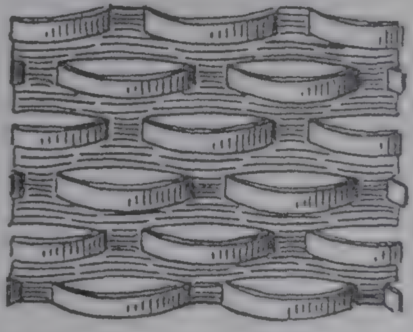


Fig. 252. Bostwick Lath

HEATING, LIGHTING, AND PLUMBING

The running of pipes and conduits in fireproof buildings brings forward a system differing in some essentials from the ordinary piping of buildings with wooden floors. In the first place, less cutting of material is possible to make spaces for pipes, and so more careful consideration must be given to their placing in the early stages of the construction; and, again, the necessity of leaving no continuous channel or connection from one floor to another, which would allow the passage of fire, requires that the pipes be run in exposed situations so far as possible, so that the floor material may be filled closely around each pipe. This is a point that the superintendent will need to keep constantly in mind and be sure that it is done in every case.

Plumbing Pipes. The main soil, waste, and vent pipes should be of wrought iron with screw joints, not only on account of the great weight of the high stacks of pipes, but also because the expansion and contraction of the great height of pipe would destroy the lead calking usual with cast-iron pipes. The pipes must be securely fastened to the solid frame of the building, and all joints well screwed together with ample allowance for expansion. Brass supply pipes should be used throughout, nickeled or bronzed to taste when showing. As the pipes will all show, the soil and waste pipes need to be smooth and well put together so that when bronzed or finished they will not be unsightly.

Gas Pipes and Electric Conduits. Before the plastering is begun, the pipes for gas and the conduits for electric wires must be run. These, being small, may be concealed, although the idea of exposing gas piping is coming more into vogue, especially where thin partitions are used. When the partitions are made of hollow blocks, it is customary to channel them so that the rising pipes and conduits may easily be carried through; while the horizontal pipes are usually bedded in the concrete filling over the floor construction, Fig. 253.

There are some types of construction where the horizontal pipes are run under the floor beams, the suspended ceiling being dropped low enough to allow free circulation for the pipes. Sometimes the pipes are run between the floor beams; but if the girders are framed flush, it will be necessary to punch holes in them, and lateral branches cannot be easily managed. Where no partitions are available in which to run vertical pipes, as often occurs in the lower stories, the casing of the steel columns may be enlarged, to allow for the pipes; but if this is done, a separate flue outside the column casing, as in Fig. 254, should be made, since the insertion of pipes or conduits directly into the column casing destroys its fireproof value to a large extent, besides subjecting the steel to the action of injurious gases.

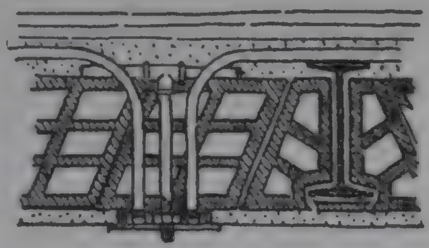


Fig. 253. Electric Outlet in Terra Cotta Ceiling

Heating Pipes. The pipes for heating the building, are, as a rule, run outside of the plaster, and are bronzed to match the radiators and other exposed piping. The number and size of the pipes depend upon the system of heating used. For a large building, the heating is generally put in charge of an engineer who devises a system subject to the approval of the architect, but some stated conditions will in general be found to apply to most buildings.

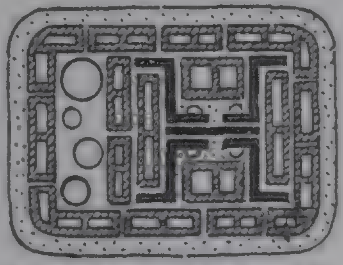


Fig. 254. Conduit Pipes in Column Casing

Heating System. In almost every large building, the exhaust steam from the engines necessary to run elevators and dynamos suffices to heat the rooms, and this heat may be made available in either one of two ways. The exhaust steam may be forced or drawn through the radiators so that it transmits heat directly to the building; or it may be carried to a coil in a water tank in the basement where it will heat the water, causing it to circulate through the pipes and radiators instead of the steam. By the latter method a more nearly uniform distribution of heat is obtained, and any danger of back pressure on the engines is avoided. It is important to see that the tank is placed low enough to prevent any backing-up of the water to the engine.

The circulation of hot water to the radiators may be laid out in a manner similar to the circulation from an ordinary heater, which has been previously described. The greater height and multiplication of radiators require a much more complicated system of piping, but the main features are the same. The most effective service is, of course, obtained by putting as few radiators as possible on a direct circulation, but, as this adds very much to the expense, it is quite usual to run one or two large mains up to the top floor, and from a horizontal run in this story to bring down the hot water to supply the radiators, the pipe being continued to the heater.

This of course gives a better supply to the top stories than the lower ones, and the difference is made up by making the lower radiators larger. The first story, exposed to the cold from big windows and doors, is sometimes supplied directly from the risers, and the discharge returned by separate pipes to the tank, while the other radiators, being supplied by a descending current, receive the steam from the same pipe into which it is discharged without interfering with the circulation.

The system of indirect steam heating by means of a fan is often to be preferred for the large stores or corporation offices, which usually occupy the lower story of a city block. For the heating of the smaller upper offices, it is a good plan to drop a riser, as described, between each pair of windows, a small radiator being placed in front of every window. These may be supplied with fresh air by means of sash ventilators or other fresh-air inlets, or they may warm the room by direct radiation.

Lavatories. The plumbing fixtures of an office building need not differ to a great extent from house fittings, and the same principles of construction apply. The fixtures consist mainly of bowls, or sinks, and water closets and urinals. All fittings should be strong and of simple construction, easily accessible for repairs or cleaning. The use of wood for partitions or floors should be avoided when possible, marble slabs and marble, mosaic, or tile floors being preferable. Water closets need to be placed in well-ventilated ranges, with partitions of marble or other impervious material, and slatted doors kept up a foot from the floor. All hinges, fastenings, and metal fixtures should be of nickel-plated brass. Urinals of the ventilated-hood pattern are to be preferred and these should have a dished floor slab of ample dimension.

Structural Glass. As an improvement on marble for toilet partitions, opaque glass is often used. This has the quality of being entirely nonabsorbent and unstainable, remaining permanently clean and sanitary. The glass can be obtained in slabs up to 6 or 7 feet in width, and 9 or 10 feet in length, and of a thickness suitable to the purpose required. For dadoes or other slabs which are applied to a backing, $\frac{7}{16}$-inch or $\frac{1}{2}$-inch slabs may be used; when standing free, as for partitions, the slabs should be $\frac{3}{4}$ or 1 inch in thickness and polished both sides. For toilet rooms a high polish is desirable as this is more sanitary and presents a surface upon which it is impossible to write.

Caps and base members, coves, and tile shapes can be obtained to set against a cement backing in the same manner as ordinary tiling. This form of structural glass is known to the trade as "Carrara", "Opalite", or some other name suggestive of its particular quality or appearance.

FINAL BUILDING OPERATIONS

Plaster. The use of the so-called "hard plaster" for the finishing of business and public buildings is to be advised wherever the slight increase in expense can be borne. For business blocks the saving in time will usually more than cover the extra cost, and for schools and hospitals the harder and cleaner surface is very desirable. These plasters are made, some of natural cement and others by chemical preparation, and when dry they form a clean, hard surface.

Natural Cement Plaster. The natural cement plaster is slower in setting, but of great adhesiveness, while the chemical or patented plasters set very quickly and give good results when properly used. The cement plasters are sold as a cement only, and the sand is applied when the mortar is mixed. For use on lathing, "fibered cement" should be obtained, but for plastering on brickwork or terra cotta, cement without fiber may be used. These cements are known as "Acme", "Agatite", and "Royal Cement".

Chemically Prepared Plaster. The best known of the chemically prepared plasters are "King's Windsor", "Adamant", and "Rock" plaster. These are sold with the fiber and sand all combined and ready to use after being mixed with water in the prescribed proportion. Full instructions for use are furnished by the manufacturers, and these directions should be followed absolutely, as they are the result of careful preparation and long experience. The plasters can be finished with a white coat as upon lime mortar, and this will be necessary if a white finish is desired upon the natural cement plasters, which are themselves gray in color.

Plaster for Bases, Dadoes, Columns. For a very hard finish for bases, dadoes, columns, etc., or for any plaster work where a polish is required, Keene's cement, an English preparation, is generally used; but some of the best grades of American manufacture are said to be as hard and less expensive than the imported cement. Keene's cement is sold in two grades, coarse and superfine, either of which will make a hard finish, but superfine must be used to secure a polish.

Scagliola. For interior finish on columns, dadoes, etc., scagliola, or imitation marble, is used to some extent. This is made upon a ground of lime mortar containing a large proportion of lime and hair. When this groundwork is thoroughly dry, it is covered with a coat of Keene's cement on plaster of Paris, which is mixed with the various colors and polished until it resembles marble. For flat surfaces, this is sometimes made in slabs upon plate glass. Silk threads, dipped in a thin solution of plaster of Paris, colored to imitate the veining, are arranged upon the glass, and the body color put on over them. The silk threads are then withdrawn, and a backing of plaster of Paris and cement, with a webbing of canvas, is spread to the desired thickness. The slabs, when hard and dry, may be taken from the glass and polished in the same manner as genuine marble. When scagliola is skilfully made and polished, its resemblance to genuine marble is almost perfect.

Window Frames and Windows. It has been the custom to make the window frames and sashes of a fireproof building of wood, in the same manner as the frames in ordinary city buildings, shutters of tinned wood or metal construction being depended on for protection against outside fires. Later developments in fireproof construction, and the disastrous effects of fires in the vicinity of many so-called fireproof buildings, have led to the growing use of metal for all external parts. Several patented forms of metal frames and sashes have been introduced, among which are some made of wood and covered with metal, as shown in Fig. 255, and others entirely of metal, Fig. 256.

The windows are arranged to close automatically, and, when glazed with wire glass or with small lights of prismatic glass in metal bars, form a filling which is acceptable to most of the insurance exchanges. This style of glazing is, of course, not adapted to show windows and large store lights, but as the upper stories, in which it can be used, are subjected to the greater danger from fire in adjoining buildings, this defect does not mar its usefulness.

Doors and Other Inside Finish. While wood is still employed to some extent for the inside finish of fireproof buildings, the use of incombustible material is increasing. The forms of metal-sash construction which we have described for outside windows can all be adapted to interior uses, and, with metal doors and frames, and marble or mosaic floors, each office made practically fireproof in itself. Doors with sheet-metal coverings are often used, either plain or molded to resemble wooden doors, and they may be set in cast-iron frames made with rebates or channels to receive the plaster or block partitions, Fig. 257. These doors are made of hollow metal with a wooden or composition core completely encased in sheet metal, Fig. 258.

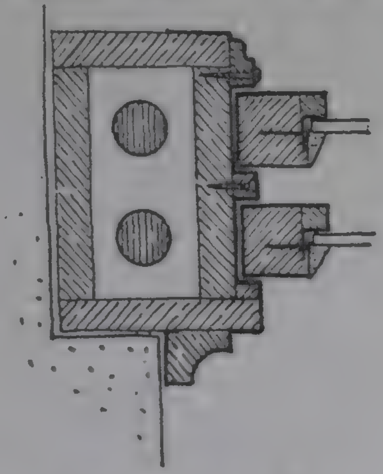


Fig. 255. Section of Wood-Covered Fireproof Window

Influence of Insurance Rates. This use of metal for doors and for other finish has been stimulated by the requirements of the National Board of Fire Underwriters. In order to obtain the lowest possible insurance rates, it is necessary to install fittings which are approved by this body, and in the manner required by them; consequently, when doors or windows of this nature are specified for certain localities, it is not necessary to state the quality of the material or the construction, but only the desired appearance and finish when completed, as the door or window must be exactly in accordance with the sample which has been approved by the underwriters for each individual manufacture. For instance, in order to procure a "Standard" door, it is not necessary to give any other specifications than that "the door shall be Standard, and bear the labels of the Underwriters' Laboratories".

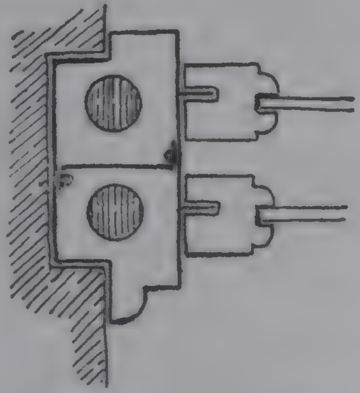


Fig. 256. Section of Fireproof Window Entirely of Metal

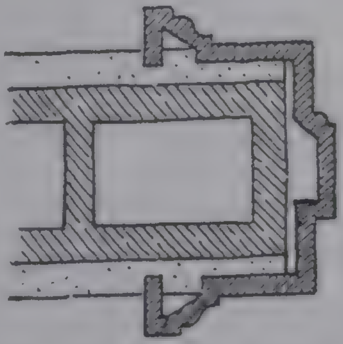


Fig. 257. Section of Cast Iron Door Jam

In non-fireproof buildings or semi-fireproof buildings, the insurance requirements are not so strict, and the safety of this type of building is usually guarded by local or municipal laws.

Sliding Doors. When sliding doors are to be used, especial care must be taken to select a good hanger, which will give the essentials of freedom from noise, ease of motion and adjustment, as well as durability.

For ease of running, a ball-bearing hanger is best, and for noiselessness a type in which the wheel runs on a wooden track is essential. For sliding doors in residences, a single line of track will usually suffice, but for schools, classrooms, and elevator enclosures, runs of parallel tracks with trolleys of different speeds are often required. Accordion or folding partitions are required in many classrooms and auditoriums, and when these are installed, swivel hangers become a necessity. The remaining hardware for sliding doors consists chiefly of recessed cup handles and a special lock and key.

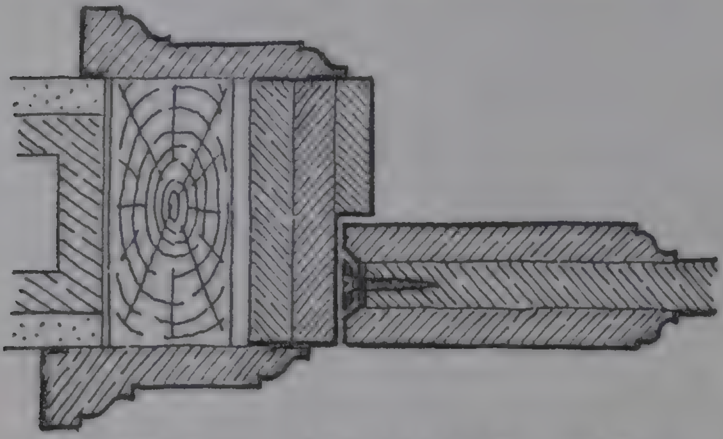


Fig. 258. Section of Sheet Metal Door and Finish

Stairs. As the stairs of a high building are rarely used above the first stories, except for emergency, or at times when the elevators are not running, it is the custom to make staircases simple in design and construction, except perhaps the lower flights, which are often of marble or ornamental iron or steel. A simple form of stair construction, and one in general use, consists of a plain cast-iron riser and marble or mosaic treads, Fig. 259. The outside stringer may be more or less ornamental, and the soffit or underside of the flight should be neat and presentable, as it will be in close view when passing down the flight underneath. The stairs should be arranged so that the stringers will not be too long to be of cast iron, if desired; but sometimes a steel beam or channel is used with the forming for the steps bolted on, Fig. 260. Whether the cast-iron or steel stringer is used, the bottom and top of the stringers must be securely fastened to the floor beams.

Sometimes the stairs are laid out to enclose one or more elevators in the well room, and in this case a support for the stringers can be obtained by the corner posts of the elevator enclosure, which, in turn, will be strengthened by the lateral support of the stairs.

Painting. With the hanging of the doors and the setting of the hardware, the mechanical processes will be completed, and the building will be turned over to the painters for finishing.

The methods and materials differ little from ordinary painting, varying mainly in the smaller amount of woodwork and the greater amount of finished metal and plaster work to be treated. All iron or steel work which is to be painted must be perfectly clean and free from rust or moisture. Rust spots can be removed by scraping or burning. The paint on fine ornamental work must be carefully applied in thin coats so as not to obscure the pattern. Plaster which is to be painted must be free from flaws or cracks, and both plaster and wall behind it must be thoroughly dry. Plastered walls should be brushed over just before painting, and the surface sized or primed.

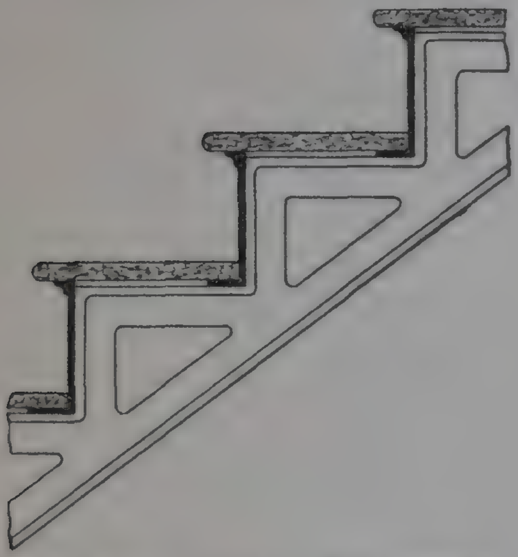


Fig. 259. Cast-Iron Stair Stringer and Finish

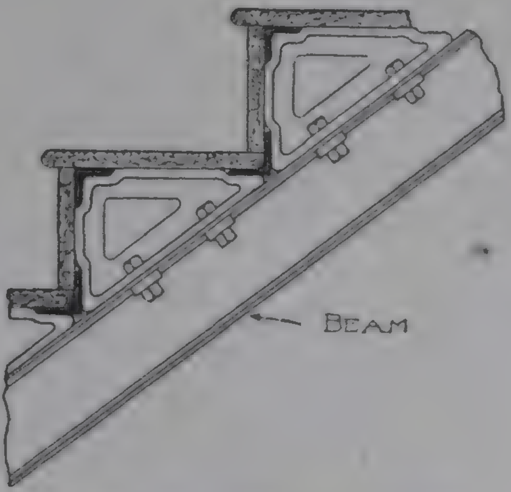


Fig. 260. Beam Stair Stringer and Finish

FINAL INSPECTION

With the departure of the painters, it remains only to see that the building is thoroughly cleaned from top to bottom, and that all paint spots have been removed from glass, marble, and all other exposed material.

The superintendent should carefully review all notes and memoranda made during the progress of the work, and be prepared to furnish a complete and detailed account of proceedings, including a record of all orders received and given, materials rejected, and the defects which warranted their rejection.

A diary should be kept, recording the state of the weather, the number of men of the different trades employed, the progress from day to day, a record of accidents, and any other data which would be likely to prove of value or interest. A record of this sort may not only be of use to the owner, but will contain data which may be of great value to the superintendent as a guide for future operations.

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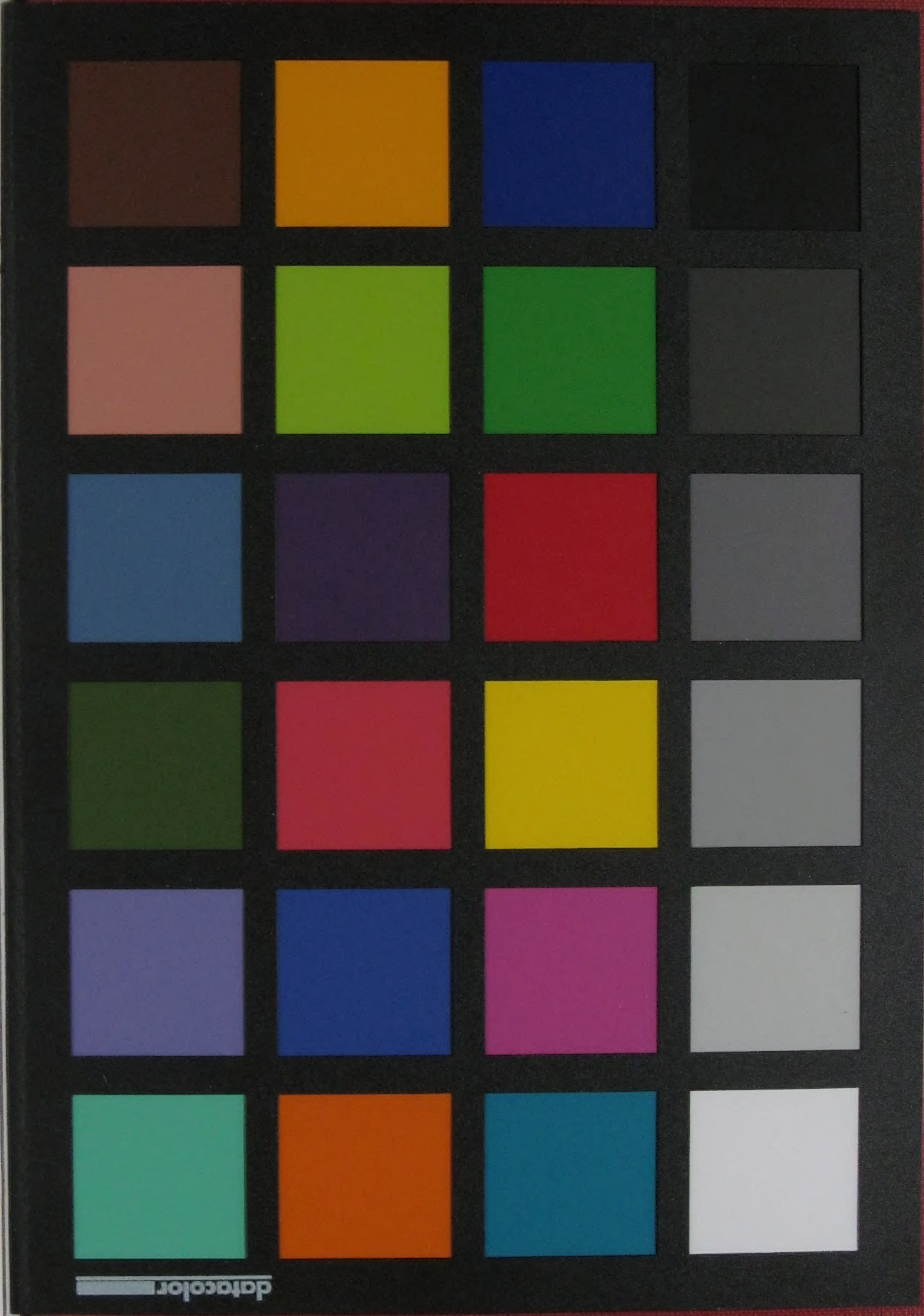
A strong mixture - and damp proof

By volume -

10 parts cement
1 " lime
30 " sand



BUILDING SUPERINTENDENCE FOR FRAME, BRICK AND STONE STRUCTURES

NICHOLS